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U.S. Mineral Resources

Bulletin 75

DEPARTMENT OF THE INTERIOR
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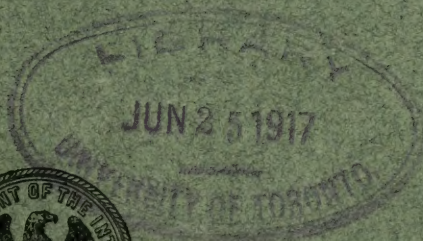
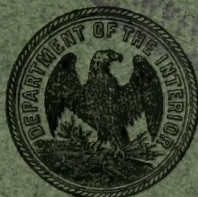
JOSEPH A. HOLMES, DIRECTOR

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RULES AND REGULATIONS FOR
METAL MINES

BY

W. R. INGALLS, JAMES DOUGLAS, J. R. FINLAY,
J. PARKE CHANNING
AND
JOHN HAYS HAMMOND



WASHINGTON
GOVERNMENT PRINTING OFFICE
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RULES AND REGULATIONS FOR METAL MINES.

By W. R. INGALLS, JAMES DOUGLAS, J. R. FINLAY, J. PARKE CHANNING, and JOHN HAYS HAMMOND.

CHAPTER I.

HISTORY OF THE COMMITTEE AND ITS INVESTIGATIONS.

By W. R. INGALLS, CHAIRMAN.

The committee making this report, consisting of Walter Renton Ingalls (chairman), J. Parke Channing, James Douglas, James R. Finlay, and John Hays Hammond, was originally appointed at a meeting of the American Mining Congress at Denver, Colo., in November, 1906. The object of this appointment was the drafting of a modern law governing quarrying and metalliferous mining which could be recommended to the several States for adoption, in the hope that the passage of such a uniform law by the mining States would tend to lower the number of fatal and serious accidents.

The first step of the committee (the personnel of which has remained unchanged from the beginning) was to procure copies of existing laws from the officials of the several States of the Union. With the assistance of the Engineering and Mining Journal, copies of the laws of Great Britain, the Transvaal, New South Wales, Victoria, Queensland, Western Australia, Tasmania, New Zealand, and certain European countries were also obtained. The replies to the inquiries made at that time developed the fact that a number of States in which mining was carried on had no laws at all. Other States were found to have elaborate provisions regulating coal mining, but none applying to metalliferous mining. Still other States were found to have miscellaneous and unrelated provisions passed at odd times, seemingly as the result of the occurrence of some disaster or other.

Colorado, Missouri, Montana, and New York were found to be the only States that had enacted mining laws of broad scope applicable to other than coal mines. The following States were found to have laws applying to collieries only: Alabama, Illinois, Iowa,

Michigan, Ohio, Pennsylvania, and West Virginia. California, Arizona, Idaho, Kansas, Michigan, Minnesota, Nevada, New Mexico, North Carolina, Oregon, South Dakota, Tennessee, Utah, Washington, and Wyoming were found to have statutes pertaining to metal-liferous mining, but with few and incomplete safety provisions. Connecticut, Louisiana, Massachusetts, New Hampshire, Rhode Island, Vermont, and Virginia were found to have no laws upon the subject, notwithstanding the fact that underground mining is, or has been, conducted in all of these States.

Believing that the publication of the laws of Colorado, Missouri, Montana, and New York would be of interest and value to those engaged in mining, and that the labors of the committee would be aided by criticisms of the existing general laws, the committee recommended to the American Mining Congress at its meeting held at Joplin, Mo., in November, 1907, that such laws be printed. This recommendation was adopted, and the committee was continued. At the request, however, of the officers of the American Mining Congress, and with the idea of obtaining the widest possible circulation and the fullest possible criticism, the first publication of such laws, in the form of a digest, was made in the *Engineering and Mining Journal*, a general invitation being extended to everyone to criticize the laws both for omissions and for improper provisions. This digest was afterwards published by the American Mining Congress in December, 1908.

After a careful study of these laws, the next step of the committee was to prepare a preliminary draft of a law, which was submitted to the American Mining Congress at its 1909 meeting. This draft was a composite of the existing laws of the several States, of Great Britain, and the British colonies. The committee decided to exclude from consideration the laws of Germany, France, and other non-English-speaking countries, for the reason that a more minute degree of regulation existed there than would be approved by sentiment in this country, so that the inclusion of provisions taken from such laws would operate to prevent the adoption of the proposed law by the mining States generally.

This first draft was printed in a limited edition by the American Mining Congress in July, 1909, for the purpose of obtaining advice and criticism, which was invited by the committee. The draft was also published in the *Engineering and Mining Journal*, which threw open its columns to all interested, with the idea of procuring a full discussion of the proposed law. The committee also took steps to place the draft in the hands of mine superintendents generally. In this way a great many suggestions and ideas were obtained that were of much value.

At the request of the chairman of the committee, Mr. Frederick L. Hoffman, statistician of the Prudential Insurance Co., of Newark, N. J., summarized and reviewed the available statistics of fatalities in metalliferous mining in the United States. Mr. Hoffman's report was published in the *Engineering and Mining Journal* of March 5, 1910. No such summary of fatal accidents in the United States had theretofore been compiled. The deficiencies of his report were frankly recognized by Mr. Hoffman. He made the most out of the data available, but unfortunately, to the discredit of our mining industry, the available data were scanty. For only six States was it possible to procure statistics extending over a long series of years. The other States had not reported them. Consequently, the figures reached by Mr. Hoffman had to be regarded as merely indicative rather than absolute.

Up to this time all the work of the committee had been done under the auspices of the American Mining Congress, but the American Institute of Mining Engineers and the Mining and Metallurgical Society of America having become interested in the work and having invited the committee to serve also as a committee of their respective organizations, the American Mining Congress, at its meeting in November, 1909, authorized the committee to make a joint report to the three organizations. From this time on the committee acted on behalf of each of these organizations.

On the basis of the criticisms and suggestions received concerning the preliminary draft, the committee next undertook the preparation of another preliminary draft. In this work the committee invited and received the assistance of several members of the bar, especially Dr. Rossiter W. Raymond, of New York; Mr. E. E. Ellinwood, of Bisbee, Ariz.; and Mr. Archibald Douglas, of New York. Particular acknowledgment is due Mr. Douglas for his valuable co-operation. He not only devoted a great deal of time to the matter, examining practically all of the reported decisions of the individual States construing their respective mining laws, but also drafted a law in accordance with the views of the committee. The work of the committee consisted chiefly in the consideration of the technical provisions of the law. Sessions were held at which mining men were invited to be present and were consulted regarding particular features of the proposed law. In addition, a number of experts were consulted from such companies as the E. I. du Pont de Nemours Powder Co. regarding explosives, and the John A. Roebling Sons Co. regarding wire ropes.

Under date of September 1, 1910, the committee submitted its joint report to the three organizations, together with the second preliminary draft. This was again published in the *Engineering and*

Mining Journal and further comments and criticisms invited. The draft was also published by the Mining and Metallurgical Society of America in its Bulletin of October, 1910. The report was discussed by the mining-engineering papers, by the American Institute of Mining Engineers, and by the Mining and Metallurgical Society of America. Particular acknowledgment is due the Mining and Metallurgical Society for the interest taken in the work and the many helpful criticisms received from its members. Each of the several sections of the society in New York, Philadelphia, and San Francisco took up the draft, section by section, and discussed its provisions in detail. Practically the entire sessions of the winter of 1910-11 were devoted to a consideration of the law, and each section was either approved as it stood or specific changes therein were recommended. The discussions at the various meetings were reported in subsequent bulletins of the society and were of great benefit to the committee in the revision of the draft.

In 1913 the Colorado Scientific Society entered upon a similar consideration of the proposed law and appointed a committee, consisting of Messrs. C. A. Chase, George E. Collins, Charles W. Comstock, Victor G. Hills, and Arthur J. Hoskin, to study and report concerning it. Mr. Hoskin acted as secretary. After two or three meetings Mr. Hoskin left Colorado for an indefinite period, and his place was filled by Mr. E. Lyman White, formerly State commissioner of mines, who thereafter acted as secretary. The report of this committee was published by the society in July, 1913, in a book of 135 pages. The recommendations of the Colorado Scientific Society were important as the expression of views of mining engineers and operators in a region where there are many small mines and where vein mining is the predominant characteristic of the industry. The criticisms and recommendations of the Colorado Scientific Society were carefully considered by the committee.

The committee had always entertained the idea of preparing a final draft of a law, profiting by the comments made upon its earlier work, if time and opportunity permitted. Consequently, when in April, 1911, Dr. Joseph A. Holmes, Director of the United States Bureau of Mines, invited the committee to serve as a committee of that bureau, which would undertake to provide the necessary clerical and other assistance and to attend to the publication of the report and final draft, the committee gladly availed itself of the invitation. It was realized that the labors of the committee would be considerably facilitated by such an arrangement, that it would be able to extend its studies in ways beyond its own resources, and that the Bureau of Mines was in the best position to see that the report be properly brought to the attention of and distributed among miners and mine operators, for whose common benefit the work had first been undertaken. It was

furthermore considered to be appropriate that the concluding labors of the committee should be performed under the auspices of that branch of the Federal Government that was created to promote and foster and to assist in solving the problems confronting the mining industry.

Accordingly, the individual members of the committee received appointments as consulting engineers of the Bureau of Mines in the summer of 1911. The work has been conducted since then as rapidly as the time at the disposal of the members of the committee would permit.

In arriving at the final form of the proposed law many new provisions have been added, including a section dealing with electrical practices. Numerous sections and rules have been revised and rewritten, either in whole or in part, and all the technical provisions have been reconsidered, one by one. In addition the committee has sought to avail itself of expert advice upon different features of the proposed law, and has requested and received the criticisms of recognized experts in their special fields.

Particular acknowledgment is due to the following gentlemen who have from time to time rendered assistance to the committee: To Dr. R. W. Raymond, E. E. Ellinwood, Esq., and Archibald Douglas, Esq., who have given legal advice; to Mr. J. F. Callbreath, secretary of the American Mining Congress, who cooperated with the committee in all possible ways, especially in the early years of its work; to Col. B. W. Dunn and Capt. G. E. Carlton, of the bureau of explosives of the American Railway Association, and Capt. F. H. Gunsolus, of the E. I. du Pont de Nemours Powder Co., who have advised respecting explosives and blasting; to Mr. Edwin I. Atlee, president of the Philadelphia Manufacturers' Mutual Fire Insurance Co., who advised respecting fire hazards; to Mr. Timothy W. Sprague and Mr. Charles Legrand, who advised respecting electrical rules and practice; to Mr. W. L. Saunders, of the Ingersoll-Rand Co., and Mr. Frank Richards, from whom assistance was obtained in drafting provisions and suggestions for the regulation of air compressors and receivers; to the A. Leschen & Sons Rope Co., the American Steel & Wire Co., the Broderick & Bascom Rope Co., the Hazard Manufacturing Co., the John A. Roebling's Sons Co., the Macomber & Whyte Rope Co., the Waterbury Co., and the Williamsport Wire Rope Co., who advised respecting wire ropes; to the George D. Whitcomb Co., the Milwaukee Locomotive Manufacturing Co., and many mining companies, from whom valuable technical information on the subject of gasoline locomotives and the handling of gasoline was obtained; to the Oliver Iron Mining Co., the Nevada Consolidated Copper Co., the Inland Steel Co., the Utah Copper Co., and the Chino Copper Co. for data on the safety precautions observed in

mining their open pits, as well as to a great number of other mining companies from whom much miscellaneous information was received; to Maj. Robert U. Patterson, Medical Corps, United States Army, in charge of the first-aid department of the American National Red Cross; to Prof. H. S. Munroe, Mr. G. E. Collins, Mr. Gerald Sherman, Mr. James MacNaughton, Mr. F. W. Denton, Mr. John Knox, jr., and Mr. C. W. Goodale, who were friendly and valuable critics and advisers regarding mining practice; and to all those State mine inspectors, as well as the county inspectors of Minnesota and Michigan, whose authority extends over metal mines, especially to Mr. W. W. Jones, of New York, who offered several excellent suggestions and rendered help in various ways. Special acknowledgment is also due to Dr. Joseph A. Holmes, Director, and Mr. Van. H. Manning, Assistant Director, of the Bureau of Mines, for their support of the committee and extension to it of all the facilities at the command of the bureau, and to many members of the staff of the bureau, who actively cooperated with the committee, including Mr. George S. Rice, chief mining engineer; Mr. Clarence Hall, explosives expert, and Mr. H. H. Clark, electrical expert.

Special acknowledgments are furthermore due to Mr. C. B. Dutton, of the Bureau of Mines, detailed by the director, and Mr. L. O. Kellogg, of the editorial staff of the Engineering and Mining Journal, who acted as personal assistants of the chairman of the committee and performed services that are too varied and extensive to be enumerated here, but it will be noted that several of the chapters comprised in this report, prepared by them under the guidance of the committee, are especially credited to them.

It will thus be seen that the labors of the committee have been participated in by a great many persons, who have each contributed something to the final form of the proposed uniform law. Starting with a composite of existing laws, the committee has, by successive stages, endeavored to work out a general law that would embody the best mining thought of the day, be in accord with approved modern mining practices, and yet at the same time be effective and practical in operation, and not merely a collection of rules and regulations to be disregarded or enforced at will. If it has succeeded in this endeavor, its members will feel amply repaid for the time and thought devoted to the preparation of the proposed law.

CHAPTER II.

GENERAL REPORT BY THE COMMITTEE.

In 1910, in a report upon the subject of our present investigations and recommendations made to the American Mining Congress, the American Institute of Mining Engineers, and the Mining and Metallurgical Society of America, we made the following statement with reference to F. L. Hoffman's opinion that the deaths in metal mining in the United States probably average about 3.09 per 1,000 men employed, as compared with 3.13 in coal mining:

Bearing in mind the conditions that we have mentioned above and the fact that the statistics for coal mining are far more complete than for metal mining, we surmise that the loss of life in metal mining is actually larger, proportionately, than in coal mining. This emphasizes the importance of a movement to remedy bad conditions.

Since then the report of Mr. A. H. Fay, mining engineer, of the Bureau of Mines, upon metal-mine accidents in 1912 shows a fatality rate of 3.91 per 1,000 in metal mining as compared with a rate of 3.27 in coal mining. The corresponding figures for 1911, the first year for which complete statistics were collected, were 4.19 and 3.73. In coal mining, however, there are fewer working days per year and consequently less exposure to risk. If the figures given be reduced to the 300-day basis, becoming thus the rates for 300,000 man shifts worked, the metal mines show up rather more favorably. The corresponding figures are thus 4.09 and 4.36, 4.45 and 5.09. It is probable, on the other hand, that the statistics for coal mining are as yet more complete than those for metal mining, there being a tendency in reports on metal mining to specify too large a number of employees and to neglect to report fatalities at small and remote properties. The correction of these discrepancies would tend to increase the metal-mining fatality rate.

In our former report, above referred to, we said:

In the preparation of this draft the committee has had in mind the preparation of a law that will be effective, and not merely a code of rules and regulations of which the enforcement will be largely optional. The committee has aimed to fix responsibility upon operator, superintendent, foreman, and miner, respectively, and the failure on their part to comply with the terms of the law is to be punishable by suitable penalties. The enforcement of the law is charged primarily upon the inspector of mines, who is to be to all intents and purposes a policeman.

The conditions of mining in the various parts of the United States are widely different. The basic laws of the several States also differ to more or

less extent. It has been beyond the ability of this committee to draft a law that it can say with assurance will be equitable under all conditions obtaining in mining in the United States, or will be in conformity with the basic laws of all the States. Consequently, the committee presents its present draft as a preliminary, and invites criticism for its assistance in preparing a final report.

Although the duties of this committee were limited to quarrying and metalliferous mining, the committee suggests that its draft for a law may advantageously be made to apply to all kinds of mining in those States that have no special colliery law. Coal mining and metal mining do not differ in principle to so great an extent as is popularly supposed. The fundamental rules for safety in metal mining apply also to coal mining, but the latter has dangers peculiar to itself which should be considered in special provisions in those States where coal mining is extensively carried on.

In the opinion of the committee, the essential steps toward reducing the loss of life in metalliferous mining are (1) a comprehensive and effective law, and (2) an adequate system of mine inspection. The latter is the keystone of progress. Much can be accomplished by an adequate system of mine inspection, even if a comprehensive law be lacking; but no matter how thorough and effective in theory a law may be, it will fail in its purpose unless provision be made for its sincere, impartial, and positive enforcement by an adequate system of competent mine inspection.

To obtain such a system of mine inspection the States must appropriate a good deal more money than any has yet done. Each State must have a mine inspector, and he must be provided with a sufficient number of deputies to enable frequent inspections of all operating mines to be made. One inspection of a mine in a year is not enough. The inspector and deputies must, moreover, be provided with proper funds for clerical work, traveling expenses, etc. So far as we are aware, the State of Colorado makes the largest appropriation for inspection of metal mines, its appropriation being \$25,000 per year.^a Other important mining States appropriate only \$10,000. In the opinion of the committee, such appropriations are utterly inadequate. For States possessing a mining industry of the importance of that in Colorado, Utah, Montana, Nevada, California, and, in fact, all of the States and Territories west of the Rocky Mountains, an annual appropriation of \$50,000 to \$100,000 per State is necessary. Such expenditures are thoroughly justified by the importance of the end to be gained. At the present time the number of persons killed annually by accident in the metalliferous mines of the United States is probably in the neighborhood of 500, estimating upon the rate of 2.09 per 1,000, as determined by Mr. Hoffman. In many important foreign countries the death rate is less than 1.5 per 1,000. We operate in this country at a more intense rate than in many foreign countries, and perhaps our death rate per tonnage of ore produced per man would not compare so unfavorably, and because of this more intense operation it may be impossible for us to attain the low rates of some foreign countries. It must be borne in mind that it is not only underground, but also overground, that accidents are more numerous in this country than in Europe. There is a spirit of recklessness in this whole land that leads people to take risks that the European population avoids. But certainly our mining practice is capable of great improvement with respect to the safety of the miners, and the magnitude of the annual loss justifies a large State expenditure for the purpose of its reduction.

^a This figure for Colorado was probably incorrect. The Colorado appropriation is biennial, and was \$35,600 for the years 1913 and 1914, or \$17,800 per year. The largest annual expenditure for inspection is found in Michigan, but the appropriations are made by the several mining counties.

Consequently, the committee emphasizes strongly that the reduction of loss of life in mining is dependent chiefly upon the money that the people of the respective States are willing to spend for the enforcement of their mining laws, and in such expenditures the committee urges great liberality.

It is essential that mine inspection be impartial—absolutely free from all political, personal, and selfish interests, and, moreover, that it be competent. In its draft for a law the committee has incorporated, after very careful consideration, qualifications for mine inspectors which, in its opinion, will provide the essential conditions stated above.

Upon all of the above points we continue to hold the same opinion as formerly expressed, and we adhere to the recommendations that we then made; wherefore this reiteration will be sufficient in so far as those subjects are concerned.

In the drafting of the revised code of mining rules accompanying our present report we have been assisted by the extensive discussion of our first report by the several societies to which it was addressed, especially by the Mining and Metallurgical Society of America; also by discussions by other societies and in the pages of the technical press.

We have found that a great deal of interest and attention among mine operators has been awakened by our advocacy of improved means for promoting safety in mining. However, we are under no illusion that our recommendations will be immediately and generally adopted. We consider our work to be especially of educational character rather than anything else. It will be useful in three main ways, we think, as follows:

1. As a basis for State legislation.
2. As a basis for private systems of inspection.
3. As a collection of simple rules for the guidance of everybody engaged in mining.

Since the publication of our first report several States have adopted new mining laws and amended their old ones. In this connection our code has served some purpose; for example, in the drafting of the laws that now stand on the books of the States of Nevada and Arizona. We do not expect that any State will at once adopt all of our recommendations, especially those that are essentially of legal character. We offer them as what we think ought to be and hope some day will be.

Since our first publication, furthermore, most of the mining companies of consequence have adopted inspection systems or have at least framed codes of safety rules, which have been based to a large extent on our code, notably so in the case of the Cleveland-Cliffs Iron Co. This tendency, in fact, has become one of the most important phases in the national movement for "Safety First." This is the gratifying consummation that we had in mind. Unquestionably, also, the widespread adoption of State laws providing com-

pensation for injured workmen has helped the safety movement by making accident prevention worth while.

We consider, however, that the chief usefulness of the code of rules that we have formulated will be to small operators, who frequently engage in unsafe practices without knowing that they are unsafe or without thinking about the matter at all. There is a reasonable hope that our report will be of educational value to all mining operators.

The act that we have drafted may be regarded from two angles—from the legal and from the technical. With respect to the latter we have had in mind the conditions and practice of mining existing and prevailing in the several parts of the United States. In our treatment of the matter from the legal standpoint, in which we have had the advice of good lawyers, we have refused to clothe the inspector of mines with the optional powers that are given to him under the laws of many of the British colonies, and, also, we have refused to convey to him the sweeping power that is given to health inspectors in some of our own States. A State may exercise great authority under its general police power. In the city of New York, for example, the department of health may peremptorily order a building vacated if the building be considered unsafe. The occupants if unjustly treated must look to the courts for redress. The same power could legally be conferred upon the inspector of mines. We do not, however, consider this power to be either necessary or desirable, being of the opinion that the same object may be attained in a different and preferable way.

In our draft of a law we have formulated precise rules and requirements, to which operators, superintendents, foremen, miners, and every one concerned must conform. The permissible speed in hoisting, the conditions under which ladderways must be installed, and the requirements regarding the storage of explosives, for example, are specifically stated. The inspector may neither grant any exemption nor enforce any extra precautions by exercise of his judgment. Little is left to his judgment. It proved impracticable to exclude the inspector from the exercise of discretionary power in all cases, but in the main his duty, as we have prescribed it, is merely to enforce the law as he finds it.

However, it is impossible in any law to specify respecting all of the dangerous conditions that may exist in mining. The largest number of fatal accidents occur from "falls of ground," which in the terms of a legal writing can be guarded against only in a general way. Many dangerous conditions are totally incapable of specification. Thus, it is dangerous to stope too close to the surface whereon there may be buildings. At Goldfield, Nev., several years ago, a stope was allowed to approach too near the surface. The roof caved,

a cyanide mill was undermined, and several men were killed. Although this case exemplifies a well-recognized danger, it is impossible to say that approach to within any specific number of feet of the surface is dangerous and should be forbidden. What might be unsafe under certain conditions might be entirely devoid of danger under other conditions. Hoisting may be safely conducted at a high rate of speed in certain well-timbered shafts that are perfect in their alignment, whereas in other shafts that are out of true a low rate of speed may be exceeded only at great risk. Another shaft may be in such dangerous condition because of defective timbering that it should not be used at all.

In cases of this kind, our citations being merely examples, we have provided that the inspector of mines shall call the attention of operators and superintendents to the dangerous conditions that exist, in his opinion, and request their correction. If the operator or superintendent refuse, it becomes the duty of the inspector not summarily to vacate the mine, but to apply to a court of proper jurisdiction for an injunction against the further operation of that mine. This provision gives the operators and superintendents an opportunity to be heard in their own behalf. Although this proposed procedure involves some delay, we do not believe that the latter will ever be sufficient to defeat the purpose. If dangerous conditions be at such a crisis that immediate action is necessary, the operator and superintendent will recognize them as well as the inspector.

New methods of mining, the employment of new mechanical agents, etc., have introduced new hazards to life and limb. For example, there are now numerous fatalities resulting from men coming into contact with electric wires. The most prolific single cause of mining accidents is still, however, "falls of roof," and this is the hardest thing to guard against by written rules. The only safeguards are good foremen, eternal vigilance, and common sense. In the exercise of the last the miner must participate as well as his superiors.

There are some mining fatalities so unusual in their character that they can not be guarded against in the most perfect code of rules. Thus in a lead mine in southeastern Missouri a man in the bottom of the shaft was killed by a dog leaping over the collar of the shaft and falling upon him. In the same district a headframe was struck by lightning and a round of shots to be fired electrically underground was exploded prematurely, killing a man. To such extraordinary accidents may be added the case of the miner in Tennessee who plugged and loaded a diamond-drill hole, ran 125 feet to a supposed place of safety, but in fact opposite the other end of the hole, and was shot by his own plug as if from a gun, fortunately without any great injury to himself.

The code of mining rules that has been finally drafted by the committee is the coordination of the experiences, opinions, and suggestions of a great many men who have assisted the committee in an advisory capacity and as directly employed aids. The former have included many engineers actively engaged in practice, members of professional societies, and members of the bar; the latter have included members of the regular staff of the Bureau of Mines and of the personal staffs of members of the committee. The committee has sought to obtain many points of view and to summarize many experiences. The draft that has been prepared is not offered as the last word upon this subject. There are many phases of this subject with which the committee has been unable to deal thoroughly. Thus the committee confesses its inability to formulate at the present time adequate rules covering the important subject of ventilation of mines. Similarly there are many practices in open-cut mining, by steam shovels, etc., regarding which the committee has felt unable to formulate rules. We feel, however, that the rules so far as prescribed may advantageously be applied to open mining whether it be simple quarrying or the extraction of metalliferous mineral, as well as to underground mining.

WALTER RENTON INGALLS,

Chairman.

J. PARKE CHANNING.

JAMES DOUGLAS.

JAMES R. FINLAY.

JOHN HAYS HAMMOND.

CHAPTER III.

DRAFT FOR A LAW.

By THE COMMITTEE.

The committee's draft for a law, recommended to the several mining States for their adoption, together with the committee's explanatory notes, is as follows:

AN ACT Relating to mines and mining and to regulate mining and quarrying operations, to provide for the appointment, removal, and compensation of mine inspectors, the appointment of superintendents and mine foremen, and the prescribing of their duties, to provide for the inspection of mines and quarries with a view to improving health conditions and increasing safety among miners and persons engaged in mining industries, defining words and terms used in the act and in connection with mines and mining operations, providing rules for the government of mines and mining operations, and providing penalties for any violations of the provisions of the act and penalties for violations of any duties imposed by officers under the authority of the act, and repealing all laws in conflict herewith.

SECTION 1.

DEFINITION OF TERMS.

Application.—This act shall apply to all mines in the State of _____ producing minerals within the meaning of that term, as hereinafter defined, and employing an average of 10 or more men.

Short title.—This act may be cited as the mines-inspection act.

Singular and plural numbers.—For the purposes of this act the singular number when used in reference to persons, acts, objects, and things of whatsoever kind and description shall, whenever the context will permit, be taken and held to import and include the plural number, and the plural number shall similarly be taken and held to import and include the singular.

Mine.—The term "mine" when used in this act shall include quarries, prospect openings, pits, banks, and open-cut workings employing an average of 10 or more men, and shall embrace any and all parts of the property of such "mine" and mining plant, on the surface or underground, that contribute directly or indirectly to the mining or handling of minerals. *Provided*, that when a group of workings in proximity to one another and under one management are administered as distinct units each working shall be considered a separate mine.

Mineral.—The term "mineral" when used in this act shall mean whatever is recognized by the standard authorities as mineral, whether metalliferous or nonmetalliferous, but shall not be held to embrace or include coal, lignite, gas, oil, or any substances when extracted in solution or in the molten state through bore holes.

Operator.—The term "operator" when used in this act shall mean the person, firm, or body corporate in immediate possession of any mine and its accessories

as owner or lessee thereof, and as such responsible for the condition and management thereof

Superintendent.—The term "superintendent" when used in this act shall mean the person having the immediate supervision of the mine.

Mine foreman.—The term "mine foreman" when used in this act shall mean a person who at any one time is charged with the general direction of the underground work.

Inspector and deputy.—The term "inspector" when used in this act shall signify the State inspector of mines, and the terms "deputy" and "deputy inspector" when used in this act shall mean a State deputy inspector of mines.

Excavations or workings.—The words "excavations" and "workings" when used in this act shall signify any or all parts of a mine excavated or being excavated, including shafts, raises, tunnels, entries, galleries, open cuts, and all working places, whether abandoned or in use.

Number of men.—Whenever the expressions "number of men" or "average number of men" employed in a mine are used in this act as defining or constituting classes of mines to which this act, or any specific section, clause, provision, or rule thereof, does or does not apply, such expressions shall be construed to mean the average number of men employed during the previous year, as shown by the returns to the mine inspector or by the books or pay roll of the mine, or by all of such means, and such average number shall be determined by dividing the total number of man shifts by the number of days the mine was worked during such period.

Explosive.—The term "explosive" or "explosives" as used in this act shall be held to mean and to include any chemical compound or any mechanical mixture that contains any oxidizing and combustible units or other ingredients in such proportions, quantities, or packing that an ignition by fire, by friction, by concussion, by percussion, or by detonation of any part of the compound or mixture may cause such a sudden generation of highly heated gases that the resultant gaseous pressures are capable of producing destructive effects on contiguous objects or of destroying life and limb.

Person.—The term "person" when used in this act shall be held to mean and include a firm or body corporate as well as natural persons.

Underground.—The term "underground" as used in this act shall be held to mean "within the limits of" any mine working or excavation and shall not exclude such workings or excavations as may not be covered over by rock or earth.

Employees.—The terms "employees" and "men employed" shall be held to mean all men receiving compensation from the operator, directly or indirectly, for labor or services performed in connection with the mine and shall include contractors, leasers, lessees, tributers, or anyone else similarly employed.

This act is intended to apply to all mines and quarries, regardless of the mineral substance produced, with the exception of collieries, gas and oil wells, and sulphur and salt extraction plants, in which the material is dissolved underground and pumped out through bore holes. The term "lignite" is intended to include peat. The question of oil shales is left in abeyance, as there are no oil shales worked at the present time in the United States, so far as the committee has knowledge. The definitions contained in this section do not include all the terms contained in the act, but only those of a general character, which are essential to a proper construction of the act as a whole.

The minimum of 10 employees necessary to bring a property within the provisions of this act is selected arbitrarily and may have to be changed to suit the conditions in individual States; but the committee believes that some such minimum is desirable. To inspect properly all prospects and small detached properties is almost impossible, and any such property escaping inspection tends to bring the law into disrepute. Furthermore, many extremely small-scale workings are developed by two or a few partners, who pay due attention to their own safety and may be assumed to be their own masters.

SECTION 2.

OFFICE OF INSPECTOR OF MINES.

The office of inspector of mines for the State of ——— is hereby created.

The governor of the State, by and with the advice and consent of the senate, shall appoint such inspector of mines. The inspector of mines shall be at least 30 years of age, a citizen of the United States, a resident of this State for at least one year previous to his appointment, and shall have been practically engaged in metalliferous mining, and shall have had at least 10 years' experience in underground mining in the United States of America: *Provided*, that one year's service as a deputy inspector of mines shall count as two years' experience in underground mining in determining his qualifications for said office. The inspector of mines (but not the deputy inspectors) shall have been for at least five years in charge as superintendent or foreman of a mine or mines in the United States of America employing 50 or more men underground to be qualified for such office. He shall receive as full compensation for his services a salary of ——— dollars per annum. He shall hold his office for a term of four years (the first term beginning January —, 19—), unless sooner removed by the governor, or until his successor is appointed and has qualified; and in case of vacancy by death, removal, resignation, or otherwise the governor, by appointment as above provided, shall within six weeks fill such office for the remainder of any such term of four years.

The committee has intentionally set a high standard for the inspector of mines. If this proposed code when enacted into law is to accomplish the results expected and hoped of it, its executive enforcement and administration must be in the hands of a competent person. Such person must be free from influence and alliances that would handicap his usefulness or interfere with the discharge of his duties in any way. In addition, the tenure of office must be of sufficient length and the salary such as to make it possible for the State to obtain the services of a man of wide experience and demonstrated executive ability.

The committee regards the election of mine inspectors as highly detrimental to efficient mine inspection and deems it essential that the selection of such men be removed from the field of practical politics. The inspector should be selected and appointed because of his qualifications and equipment for the position and not because of his vote-getting ability.

The selection of mine inspector as a result of competitive examination is also considered objectionable. It does not surround the office with any additional safeguards, and is open to criticism on the ground that it fails wholly to take into consideration the personality of the individual.

SECTION 3.

DEPUTY INSPECTOR OF MINES.

The office of deputy inspector of mines is hereby created. The inspector of mines is hereby authorized and directed forthwith upon the entering of the duties of his office to appoint — deputy inspectors, who shall each receive a salary payable at the rate of \$—— per annum while holding such office. All deputy inspectors appointed under the provisions of this section shall be subject at any time to removal by the inspector. The inspector shall also appoint hereafter such additional deputies as the legislature may provide, who shall be in all ways subject to the provisions of this section. In case of vacancy in the office of any deputy inspector caused by death, removal, or otherwise, the inspector of mines shall forthwith fill such vacancy. The qualifications of all deputy inspectors shall be the same as those required in the case of the inspector of mines, as set forth in section 2 of this act; except, however, that such deputy inspectors shall be at least 25 years of age, and shall have been for two years in charge as superintendent or foreman of a mine, or mines, in the United States of America employing at least 25 men underground. All deputy inspectors shall perform duties as required by this act, and shall be under the direct control and direction of the inspector of mines. In the absence or disability of the inspector of mines, any deputy designated by him shall act with like authority as the inspector of mines. In the case of a vacancy in the office of the inspector of mines, the deputy longest in office present shall act as such inspector until such vacancy has been filled, but in no event for a period longer than six weeks.

Each State will, of course, decide for itself as to the number of deputies to be appointed, the decision depending on the number of mines within the State subject to inspection, and the territory to be covered. The salary of the deputies should be commensurate with the salary of the inspector, and the qualifications of a similar high standard. In this connection the committee calls attention to its preliminary report regarding the grossly inadequate appropriations for inspection purposes in the metal-mining States. It is essential that the inspector have the power to select and remove his assistants, in order that he may surround himself with an effective organization.

SECTION 4.

RESTRICTIONS UPON INSPECTORS.

No person shall be qualified to hold the office of inspector or deputy inspector while an employee, director, or officer of any mining, metallurgical, or quarrying company, or while directly or indirectly connected with any mining, metallurgical, or quarrying company or copartnership operating in this State, either as partner or in any other capacity, or while engaged in private practice as a consulting engineer. The inspector and each deputy shall devote his entire time

to the duties of his respective office, and it shall be unlawful for the inspector or any deputy to be otherwise employed by the State of ——— or to act directly or indirectly for or on behalf of any candidate for public office or for any political party, or receive compensation, either directly or indirectly, from any candidate for public office or from any political party in the State during the term of such inspector or deputy inspector. Failure to observe the provisions of this section shall render the inspector liable to immediate removal from office by the governor without further cause shown, and such failure shall render any deputy inspector liable to immediate removal by the inspector of mines without further cause shown, and the governor and inspector of mines are hereby authorized and empowered to make removals in such cases.

SECTION 5.

PAYMENT OF SALARY AND EXPENSES.

All responsible and necessary expenses actually incurred by the inspector and by any deputy in the performance of his duties for traveling expenses, clerk hire, postage, stationery, printing, and disbursements incidental and reasonable to the office of inspector or of deputy inspector shall be paid by the State treasurer upon the warrant of the comptroller ^a issued upon proper vouchers therefor, when approved by the inspector of mines, but such expenses, together with the salaries of the inspector and his deputies, shall not be incurred in excess of appropriations by the legislature. The salaries of the inspector of mines and of all deputy inspectors shall be paid as the salaries of other State officers are paid.

SECTION 6.

LEGAL EXPENSES OF INSPECTORS.

The inspector may employ counsel to represent him or any deputy, or to assist in the prosecution of actions or proceedings brought under the provisions of this act.

In addition to the expenses allowed to the inspector, as set forth in section 5 of this act, he shall be allowed all necessary expenses and reasonable counsel fees actually incurred in enforcing the several provisions of this act in the respective courts of this State, and the same shall be paid by the State treasurer on warrants drawn by the comptroller ^a after auditing the same; all such claims and expense accounts shall be presented and passed by the inspector and approved by the court before which such proceedings were instituted. In the event of any costs being finally taxed against the State in any suit in which the State, on the relation of the inspector, is either plaintiff or defendant the same shall be approved by the court, and audited and paid in like manner as such legal expenses are authorized to be paid as aforesaid.

To avoid delay in the prosecution of purely minor offenses arising under this proposed act this section contemplates that the inspector may of his own initiative institute appropriate proceedings and engage such legal assistance as may be necessary, to avoid congesting the offices of local prosecuting officers with these minor cases which can be speedily disposed of by the court. In many instances the

^a Each State will substitute the title of the proper official according to its own system.

inspector or deputy, after filing the complaint or information with the proper court, will himself prosecute—that is, present his evidence—as is customary in the case of police officers appearing against transgressors of municipal ordinances; such cases will rarely require legal assistance.

SECTION 7.

OFFICE AND RECORDS OF INSPECTOR OF MINES.

The inspector of mines shall be provided with a properly furnished office in the statehouse in —, in which he shall keep a record of all mines in the State, a record of all mines examined either by the inspector or his deputies, showing the dates of such examinations, the condition in which the mines so examined were found, with particular reference to the safety, ventilation, and sanitary conditions of each mine so examined, the manner and method of working, all violations of the provisions of this act found, if any, the action taken thereon, and the result of such action, together with recommendations made in the case of each mine examined by the inspector or any deputy; and any other data or information pertaining to his office and acquired during the carrying out of this act. For the purpose of aiding the inspector in compiling such data it shall be the duty of each deputy to transmit from time to time, or upon request from the inspector, a complete record of all mine examinations made by such deputy, and an itemized statement of his work as such deputy in such form and covering such detail as the inspector shall in his opinion deem necessary.

All documents, plans, books, memoranda, notes, and other material pertaining to the office of the inspector of mines, or of any deputy inspector, shall be the property of the State, and shall be delivered by the said inspector, or by such deputy inspectors, to their successors in office. The inspector may at any time call for all or any papers, documents, plans, books, memoranda, notes, or other material in the hands of any deputy, who shall deliver same to said inspector upon call.

SECTION 8.

REPORTS TO INSPECTOR OF MINES.

It is hereby made the duty of the operator of each and every mine within the State coming within the provisions of this act to forward to the inspector at his office, not later than the 20th day of January in each year, a detailed report in writing, on a form prescribed by the inspector, showing the character of the mine, tonnage of product during the previous year ended December 31, the average number of men therein employed during the year, the number of days the mine was worked, the number and nature of fatal and all other accidents during the year, and such other information relative to the workings, equipment, ventilation, sanitation, means of ingress and egress, shafts, supports, safety devices, storage of explosives, and means taken to protect lives and insure safety of men in relation to any of the requirements of this act as the inspector may from time to time require. All such reports shall be filed in and become part of the records of the office of the inspector of mines. Blank forms for such reports shall be furnished by the State:

Provided, however, That in the case of any mine being operated for less than one year prior to December 31 in any year, the operator in such event shall forward a report, in like manner, covering the period during which said mine was operated: and

Provided further, That in the event of the sale or lease of any mine during any year prior to December 31, then and in that event it shall be the duty of the owner or operator so selling, leasing, or turning over such mine to a succeeding operator to supply to such succeeding operator a like report, as required in this section, covering the period of such former operations within said year; and it shall then and in that event become the duty of such succeeding operator to forward such report so turned over, together with said succeeding operator's report, for the period of said succeeding operator's operations, to the inspector of mines as aforesaid not later than the 20th day of January in each year.

In all cases, occurring in or about any mine, e^c fires, appearance of dangerous gas, breakage of ropes or other gear by which men are hoisted or lowered, overwinding while men are being hoisted, unexpected inrush of water from old workings, threatened crushing of mine workings, or any other accident, occurrence, or change of conditions tending to increase the hazards of mining, whether or not personal injury results, a report thereof, signed by the operator or superintendent, shall immediately be sent in writing to the inspector.

A failure, neglect, or refusal to make such reports or to give such information as is specified in this section, upon demand made in writing by the inspector, or by any of his deputy inspectors, shall constitute a misdemeanor and every such operator or superintendent so failing, neglecting, or refusing after written demand made as aforesaid shall be deemed guilty of a misdemeanor, and on conviction shall be fined for each offense not less than \$50 or more than \$200; and each separate failure, neglect, or refusal after demand, as aforesaid, shall constitute a separate offense.

If a State is divided into inspection districts, or if an inspector is assigned regularly to a certain number of mines by the chief inspector, it will, of course, be desirable that the deputy be apprised at the earliest possible date of any unusual occurrence in and about a mine, in order that he may examine into the same on his next inspection trip. In such a case the chief inspector may, by regulation, provide that such reports shall be submitted to him through a particular deputy. This arrangement will obviate the delay incident to the forwarding of such report to the office of the chief inspector and the communication of the substance of the report to the deputy by his superior.

SECTION 9.

DESIGNATION FOR SERVICE OF NOTICES.

Every operator of any mine within the provisions of this act shall, within 60 days after the passage of this act, file or cause to be filed in the office of the inspector of mines a designation, duly verified by such operator, appointing a person on whom all notices, warnings, or processes required to be served under the provisions of this act may be served, and giving the office, place of employment, or place of business of such person, which must be within the State and within 10 miles of the principal place of business of the operator:

Provided, however, That the inspector of mines upon formal application of an operator is authorized to waive such 10-mile requirement when, in his judgment, the object and purpose of this section may best be attained by permitting a person to be designated whose office, place of employment, or place of business is more than 10 miles distant from the principal place of business of the operator.

Such designation shall be accompanied by the written consent of the person so designated, and shall continue in force until revoked by the death or removal of the person so designated, or until revoked by an instrument in writing designating in like manner some other person upon whom such notices or processes may be served, or until the filing in such office of a written revocation of said consent executed by the person so designated. If the person so designated dies, or removes beyond 10 miles of the place of business of such operator, or files a revocation of his consent, the operator shall within 30 days thereafter designate in like manner some other person upon whom such notices or processes may be served within this State.

Services on such designated person of notices, warnings, or processes shall, in all cases arising under this act, be deemed service on the operator represented:

Provided further, That nothing herein contained shall be construed to prevent the said operator in person, or by its officers or agents, if said operator be a corporation, or any employee of such operator, from being so designated, and that the designation of such person as herein contemplated shall not prevent the service of proper or legal process on the owner or operator of a mine, or on the proper officers and agents of a corporation owning or operating a mine.

A failure on the part of any operator to carry out the provisions of this section shall be deemed a violation of this act.

This section is largely based on the requirements of the corporation laws of the State of New York. It is manifest that the inspector can not be required to travel all over the State in order to serve a notice required to be served by this proposed act. The requirement of this section that the agent for the service of notices must be within 10 miles of the principal place of business of the operator is made necessary by the fact that many mines are operated by corporations, which may have their principal place of business many miles distant from the mine, but within the State. In some cases it may be advantageous and desirable to permit the designation of a person outside of the 10-mile zone, and the inspector is given discretion to this end.

SECTION 10.

SECRECY OF RECORDS.

The inspector, or any deputy inspector, or any person employed by such inspector or deputy inspector, or any person having access to the papers filed in the office of said inspector, or in the office of any deputy inspector, shall not make public or reveal to any person or persons, either orally or in writing, all or any part of the contents of any report, complaint, or document filed in the office of the inspector of mines of this State or in the office of any of his deputy inspectors, or reveal or make public to any person or persons any knowledge or information in regard to the safety or physical or financial condition of any mine, mining rights, prospect, or mining company or concern obtained by the aforesaid inspector or any deputy inspector or employees while in the exercise of his or their official duties. Nothing herein contained, however, shall be construed to prevent any inspector or deputy inspector, or any clerk or employee of such inspector or deputy inspector, from making official reports to the governor or legislature of this State, to the inspector of mines, or to any deputy inspector, or from giving evidence in any court of justice in this State in dis-

charge of his official duty, or from informing the operator or superintendent of a mine in regard to his findings respecting his particular mine.

Any violation of any of the provisions of this section by an inspector of mines, or any deputy inspector of mines, or any employee or clerk, shall constitute a misdemeanor and shall be punished, upon conviction, by a fine of not more than \$500 or by imprisonment for not exceeding one year, or both; and any such officer or employee, so convicted, shall be dismissed from his office or employment.

SECTION 11.

DUTIES OF INSPECTORS—INSPECTION—POWERS.

It shall be the duty of the inspector of mines, in person or by deputy, to visit at least once every three months every mine in the State employing 30 or more men underground, and every other mine at least once every year and oftener if, in his opinion, the safety of the men employed within the mine so requires; and to inspect and examine into the operation, workings, timbering, safety appliances, machinery, sanitation, ventilation, means of ingress and egress, and means taken to protect the lives and insure the safety of the miners, together with the cause of accidents and accidental death therein; and, in general, to inspect and ascertain what means are taken to comply with the provisions of this act. For the purpose of making such inspection and ascertaining facts in connection with such examination, the inspector or his deputy shall have full power and authority at all hours to enter and examine any part of any mine or mining plant within this State, or any part of the workings thereof. All operators and their employees shall render to the inspector or his deputy such assistance as may be necessary to enable the inspector or his deputy to make such examination.

For the purpose of ascertaining facts in connection with any inspection, inquiry, or examination, the said inspector, or any deputy, shall have full power to compel the attendance of witnesses by subpoena, to take depositions on the service of proper or usual notice to the mine owner or operator as required in the taking of depositions, to administer oaths, and to examine, cross-examine, and take such testimony as may be deemed necessary for the information of the inspector or his deputies.

The refusal by any person to obey a subpoena issued by the inspector or by any deputy inspector, or the willful hindrance or obstruction by any person of the inspector or any of his deputies in the performance of any of his or any of their duties under this act, shall constitute a misdemeanor and shall be punished as hereinafter provided.

Any witness appearing before the inspector or before any of his deputies, in response to a subpoena so issued, who shall knowingly and willfully testify falsely to any material matter shall be deemed guilty of perjury and, upon conviction as by law provided, shall be punished for perjury.

Any legislative declaration as to the frequency with which mines must be inspected and as to the division of mines into classes for such purpose must be arbitrary in character. It is obvious that small mines may be just as dangerous as mines employing a large number of men, but all mines in a mining State, like Colorado for example, can not be visited three or more times a year without a large force of deputies. It has therefore seemed best to the committee to draw the line as is done in this section. Any State, if it so desire, may provide for more frequent inspection.

SECTION 12.

DANGEROUS MINES—DUTIES OF INSPECTORS.

Whenever the inspector shall find any mine or part of any mine in an unsafe condition by reason of any violation of any of the rules or provisions of this act, or in a condition dangerous or detrimental to the life or health of those employed therein for the same reason or by reason of defects in timbering or other means of support, in mining, in ventilation, or in sanitation, it shall be the duty of the inspector at once to serve or cause to be served a notice in writing on the operator or superintendent of such mine or on the person designated by such operator for service in accordance with section 9 of this act, and such notice shall set forth in detail the nature and extent of the defects that render the mine or part of the mine unsafe, dangerous, or detrimental to the life or health of those employed therein, together with the point or place in the mine or in the workings of the mine where such defects exist, and such notice shall require such necessary changes to be made in such mine or part of the mine without delay and within a specified time, in the discretion of the inspector, as shall make the same conform to the provisions of this act.

If it appear from a reexamination of the mine by the inspector or a deputy inspector that such necessary changes have not been made within the time specified in such notice, and that the mine or part of the mine is still in a condition dangerous to life or health, and in the opinion of the inspector it is necessary for the safety of the life or health of the employees in such mine or part of the mine that the same be vacated, it shall be the duty of the inspector forthwith to institute an action for an injunction in any court of competent jurisdiction, in the name of the State, on the relation of the inspector, to restrain the operation and working of said mine or part of said mine, and the entrance of employees therein for purposes other than to remedy the defects complained of until the provisions of this law are complied with, and the said mine or part of said mine is made safe for the employees therein; and the plaintiff in such action, without bond, and upon ex parte affidavits made by the inspector or a deputy inspector showing in detail the nature and extent of the defects that, in such affiant's opinion, render the mine or part of the mine unsafe or detrimental to the life or health of those employed therein, and stating that such mine, or part of the mine, is, in the opinion of the affiant, in a condition dangerous to life or health, may, pending the trial of said action, procure a temporary injunction from any court or judge in vacation if in the opinion of the court or the judge the facts warrant the granting of such temporary injunction, enjoining the operation and working of said mine, or part of said mine, and the entrance of employees therein, except for the purpose of remedying the defects complained of, until the further order of the court.

Provided, however, that the defendants in such actions shall have the same opportunity to be heard upon motion to vacate such temporary injunctions as defendants have in any actions brought in this State in which temporary injunctive relief may be granted.

In an act of this kind it is exceedingly difficult to anticipate all dangers that may arise in the course of mining; and, moreover, certain dangers that can be anticipated can not arbitrarily be prescribed against. Such, for example, are the dangers arising in mining by the caving system. Moreover, what may be safe in certain circumstances may be quite unsafe in others. Such contingencies might be met by conferring discretionary power on the inspector of mines,

who might even be authorized to compel the suspension of operations in a mine that in his opinion is in a gravely dangerous condition. Under the police power inherent in sovereign States very broad power can be given an inspector, if it be so desired. This question each State must decide for itself. The committee has not seen fit, however, to recommend any such exercise of power and has preferred to provide for the alternative remedy of a temporary injunction, which may be speedily obtained upon an *ex parte* showing but gives the operator an opportunity to be heard before the injunction is made permanent. This arrangement is deemed to be more equitable for the operator and to furnish equal safeguards to the miner.

SECTION 13.

REFUSING INSPECTION—PENALTY.

If the operator of any mine within the State shall fail or refuse to permit, or shall impede such inspection as is provided in sections 11 and 12 of this act, the inspector or deputy may file his affidavit setting forth such refusal before the judge of the ——— court in the county in which said mine is situated, or at the option of the inspector, in the county in which is situated the general office of the corporation owning or operating the mine, either during the term of the court or during vacation, and obtain an order directed to such operator so refusing as aforesaid, commanding him to permit and furnish all necessary facilities for the entering, examination, or inspection of such mine or to be adjudged to stand in contempt of court and be punished accordingly.

SECTION 14.

RECORDS OF INSPECTION.

It shall be the duty of the inspector or any deputy, after every inspection of any mine or parts of any mine as provided in this act, to enter forthwith in a book to be kept at the mine and designated as the "record of inspection" the parts of the mine so inspected, the nature of such inspection, and every illegal defect observed in the state and condition of the mine, machinery, and appliances; but nothing contained in or omitted from such entry shall limit or affect the duty and obligation of the owner or operator of such mine under this act. Such "record of inspection" shall be open at all reasonable times to the examination of the inspector or any of his deputies, or to the examination of any persons employed in the mine.

Provided, however, that such records shall not be in lieu of, or a substitute for, the notice required to be served by section 12 of this act.

SECTION 15.

COMPLAINTS TO INSPECTORS.

Whenever the inspector receives a complaint in writing, signed by 3 or more persons employed in a mine, if less than 25 persons are employed therein, or by 5 or more persons employed in a mine, if more than 25 and less than 100 persons are employed therein, or by 10 or more persons employed in a mine, if more than 100 persons are employed therein, setting forth that the mine in which they are working is being operated contrary to law and is in any respect dangerous to the health and lives of those employed therein, the inspector shall in person

or by deputy examine such mine as soon as possible. The names of the persons making such complaint shall be kept secret by the inspector, unless permission to disclose them be expressly granted by the persons making the complaint.

Provided, however, that such complaint shall, in all cases, set forth the alleged violation of law observed, the nature of the danger existing at the mine, and the time when such violation or danger was first observed. If on inspection the inspector find the conditions, in his opinion, dangerous to the health and lives of those employed therein, by reason of any violation of any of the provisions and rules of this act, he shall serve, or cause to be served, a notice setting forth fully the facts upon which his opinion is based, as provided in section 12 of this act.

It shall be the duty of the inspector or any deputy to forward every such original complaint so received to the office of the inspector of mines, where it shall be indexed and filed among the official papers of the inspector of mines.

The committee recognizes that miners are prone to complain on insufficient grounds and has endeavored to guard against this by requiring the complaint to specify the nature of the danger and the time when the violation of the law or danger was first observed, and by requiring the complaint to be signed by a number of persons, gaged according to the total number of men employed. On the other hand, if the mine be really in a dangerous condition from one cause or another, it should be made reasonably easy for those cognizant of the danger to bring the danger effectually to the notice of the inspector or his deputy.

SECTION 16.

ACCIDENTS.

Whenever a serious accident occurs in or about any mine, notice thereof shall be given promptly by telephone or telegraph, followed by a notice in writing, to the inspector by the superintendent or other person having immediate charge of the work at the time of the accident. The words "serious accident" shall be construed to mean, for the purposes of this act, accidents resulting in such injuries as, in the opinion of an accredited physician, may result in the injured person being incapacitated from work for at least 14 days. Upon receiving such notice the inspector or a deputy shall, if feasible and if the nature of the accident shows it to be necessary, proceed to the scene of the accident with all convenient speed and investigate fully the cause of the accident, and, within 20 days thereafter, shall file the result of such investigation as a report in the office of the inspector. Whenever the inspector or a deputy can not proceed as above to the scene of the accident, the person in charge of the mine shall be so informed by the inspector, and such person in charge shall obtain sworn statements of those who witnessed the accident, or if no one was present at the time of such accident he shall obtain the sworn statement of those first arriving upon the scene. Such statements shall give, as far as possible, the details of the accident, the facts leading up to it, and its probable cause: such sworn statements shall immediately thereafter be sent to the inspector, who shall file the same in his office as public records.

To define properly a "serious" accident is somewhat difficult. About the only feasible method of differentiating "serious" from "minor" accidents is on the basis of the length of the period of dis-

ablement. The committee has made the dividing line 14 days. This is a figure commonly so taken in reporting mine accidents, and corresponds with the length of time elapsing before an injured employee receives compensation, according to most of the compensation laws of which the committee has knowledge.

SECTION 17.

LOSS OF LIFE.

Whenever loss of life occurs from accident in or about a mine, and when death results from personal injury, the superintendent or other person having immediate charge of the work at the time of the accident shall give notice to the inspector promptly by telephone or telegraph, followed by notice in writing, after knowledge of death comes. Whenever possible, the inspector or a deputy shall be present at a coroner's inquest held over the remains of a person killed in or about a mine. An inquest held by the coroner upon the body of a person so killed shall be adjourned by the coroner for not more than —— days at the request of the inspector. If the inspector or any of his deputies be not present at such inquest, the coroner in such case shall give written notification of such adjourned inquest and the time and place of holding the same at least five days previous thereto, to the inspector or to his deputy intending to be present. Due notice of an intended inquest to be held by the coroner shall be given by the coroner to the inspector, and at such inquest the inspector and any deputy inspector shall have the right to examine and cross-examine witnesses, and such examination shall be part of the records of such inquest. If, at any inquest held over the body or bodies of persons whose death was caused by an accident in or about the mine, the inspector or any deputy be not present, and it be found from the evidence given at the inquest that the accident was caused by neglect or by any defect in or about the mine, or because the mine was operated contrary to the provisions of this act, the coroner shall send notice in writing to said inspector of such reported neglect or default; and the said inspector shall immediately take steps to have an investigation made of the same. The coroner before whom such an inquest is held shall promptly file with the inspector of mines a copy of the testimony taken thereat and a copy of the verdict rendered by the coroner's jury.

SECTION 18.

INSPECTOR TO FORWARD PAPERS TO PROSECUTING OFFICER IN CERTAIN CASES.

Whenever, in the opinion of the inspector of mines, a serious or fatal accident in or about any mine in this State shall have been caused by failure on the part of the operator or any employee of such mine, or by any other person, or by any of them, to observe the provisions of this act, it shall be the duty of such inspector to cause a copy of the report of such accident, or a copy of the testimony taken at the coroner's inquest, together with the verdict of the coroner's jury, and all papers in his hands relating thereto, to be forwarded to the prosecuting officer of the county in which the accident or loss of life occurred, together with a statement of the inspector showing in what particular or particulars he believes the law to have been violated, and if upon the receipt thereof the prosecuting officer of the said county deems the facts to make a prima facie cause of action against any party, he shall present such evidence to the grand jury and take such further steps for the criminal prosecution of such operators, employees, or other person as may seem advisable.

This section contemplates a prosecution in the case of either a serious or a fatal accident caused by neglect or failure to observe the provisions of the act. Of course, before a prosecution can be initiated it will be necessary to obtain evidence indicating at least a violation of the law, and it has seemed to the committee that if a sufficient showing of disregard for the law can not be made to justify a grand jury in returning a true bill, the operator should not be compelled to stand the expense and trouble incident to a trial. For this reason the provision in some of the Australian laws making the occurrence of a serious or fatal accident *prima facie* evidence of neglect or violation of the law has been disapproved.

SECTION 19.

STATISTICAL REPORTS OF MINE INSPECTOR.

It shall be the duty of the inspector of mines within three months after January 1 in each year to make a report directed to the governor and legislature of this State, giving a statistical summary and report of the work of the inspector and deputy inspectors of mines during the previous year ended December 31. Such report shall contain a statement showing the number of men employed in each mine in the State, stating separately the number of men employed above ground and underground, the number and nature of fatal and serious accidents occurring in each mine, the number of inspections made, complaints filed, inquests attended, mines ordered to be vacated, violations found, and any other information deemed important and relevant by the inspector of mines, together with such recommendations as, in the judgment of the inspector of mines, are necessary or desirable to the carrying out of this act and to insure the health and safety of the workmen employed within the mines, subject to the provisions of this act. Copies of such report shall be published and distributed by and at the expense of the State as a public document.

SECTION 20.

REMOVAL OF INSPECTORS.

Upon receipt of a petition, signed by at least 100 miners or 10 operators, or by 3 operators each employing 100 men underground, setting forth that the inspector or any deputy neglects his duties as prescribed in this act, or that he is incompetent and unqualified for the office of inspector or deputy, as the case may be, under this act, or guilty of malfeasance in office, or guilty of any unlawful act tending to the injury of miners or the operators of mines, it shall be the duty of the court of ——— of the county wherein such inspector or deputy inspector resides to issue a citation in the name of the State to the said inspector or said deputy inspector to appear upon not less than 15 days' notice, on a day fixed, before said court, and the court shall then proceed to inquire into and investigate the allegations of the petitioners. If the court shall find that said inspector or deputy inspector so petitioned against is neglectful of his duties as prescribed in this act, or that he is not qualified under the provisions of this act for such office, or that he is incompetent to perform the duties of his office, or that he is guilty of malfeasance in office, the court so finding any or all of such facts shall certify the facts so found to the governor of the State, in the case of such finding against an inspector, and to the inspector of mines, in

the case of such finding against a deputy inspector, and the governor or inspector, as the case may be, shall declare the office of inspector or of such deputy inspector vacant, and steps shall forthwith then be taken to appoint a properly qualified person to fill such vacant office of inspector or deputy inspector, as the case may be, for the remainder of the unfilled term of the removed official.

The cost of said investigation shall be borne by the removed inspector or deputy inspector, but if the allegations in the petition are not sustained, the costs shall be paid by the petitioners.

In drafting this section it was the intent of the committee that an inspector or deputy should be subjected to the indignity of a trial only when serious and palpable ground for complaint should exist. If the inspector or any deputy is grossly incompetent, or is guilty of malfeasance, or is neglectful of his duties, such fact or facts should be sufficiently a matter of common knowledge to enable the requisite number of signatures to be obtained to a petition. It will always be possible for a less number of miners or operators, or both, to petition the governor directly or to file with him individual complaints, but in view of this section the governor would be justified, except, perhaps, in the case of charges of peculiar gravity, in declining to act thereon unless such petition or complaint assumed the proportions contemplated by this section. The number of miners' or operators' signatures required must be arbitrarily chosen. Probably each State would select figures to suit its conditions existing; thus the requirements in Wisconsin are entirely different from those in the neighboring State of Minnesota.

SECTION 21.

SUPERINTENDENT TO BE APPOINTED.

The operator of every mine shall appoint a man who shall be personally in charge of the mine and the performance of the work done therein who shall be designated as the "superintendent": *Provided, however,* That nothing herein contained shall prevent the owner or operator of any mine from personally filling the office of superintendent.

The superintendent of every mine shall inspect or cause some competent person or persons appointed by him to inspect all mining appliances, boilers, engines, magazines, shafts, shaft houses, underground workings, roofs, pillars, timbers, explosives, bell ropes, speaking tubes, telephones, tracks, ladders, dry closets, and all parts and appliances of said mine in actual use, and any such person or persons appointed by the said superintendent shall at once report any defects therein to the superintendent. It shall be the duty of the superintendent upon ascertaining such defects to take immediate steps to remedy the same so as to make the same comply with the provisions of this act, and he shall forthwith notify the operator of said mine of the existence of such defects. It shall be the duty of the superintendent to appoint a competent man to have full charge, under the direction of said superintendent, of every magazine containing explosives situated on such mining property, and to make such other appointments and perform such other duties as are provided by this act to be performed by such superintendent.

SECTION 22.

MINE FOREMAN TO BE APPOINTED.

The superintendent of every mine shall appoint a man who shall be personally in charge of the development of the underground workings of the mine and personally direct the work of the men employed underground therein, who shall be designated as the "mine foreman": *Provided, however,* That nothing herein contained shall be construed to prevent the superintendent of any mine from also filling the position of mine foreman. No person shall be appointed to the position of mine foreman who shall not be at least 21 years of age, and shall not have had at least two years of practical experience as an underground miner in metalliferous mines, and shall not be able readily to read and write the English language. The failure of a superintendent to make such appointment of mine foreman, or the neglect or failure of a superintendent to appoint another in his place, in the event of said mine foreman vacating or losing his position from any cause, shall constitute a misdemeanor, and shall be punished as hereinafter provided. Such appointment shall be made in writing, and it shall be the duty of such superintendent to keep posted notice of such appointment or reappointment, immediately after the same shall have been made, in at least two conspicuous places about said mine, and notices of such appointment or any reappointment shall be mailed immediately thereafter to the inspector of mines.

The mine foreman shall attend personally to his duties in the mine as provided in this act, and shall see that the regulations provided herein for insuring the safety of all men employed in such mine are carried out: he shall immediately report to the superintendent of the mine or, in the absence of the superintendent, to the mine operator any violations or infringements of this act observed by him within the mine, and shall take immediate steps to remedy the same. He shall warn all employees of danger to life or limb observed by him within the mine, and permit no person to work in an unsafe place, unless for the purpose of making it safe or when work in such a place is necessary and unavoidable: and shall supervise the miners in the performance of their work.

It shall be the duty of the mine foreman to see that the number and identity of the men going underground on every shift is established and that all such men return to the surface at the end of their shift.

The third paragraph in this section is regarded as a highly necessary provision. It is designed to serve two useful purposes, namely, to prevent the possibility of a man's being injured and left in some remote working place for a long period of time, and in the case of serious accidents, such as fire or flood or caving, which involve the whole mine, to make it easier to ascertain when all the men have been rescued.

Working in unsafe places in a mine can not be entirely prohibited, for such work is frequently necessary and unavoidable. In such cases a competent mine foreman can be trusted to see that all practicable precautions are taken, and in that event accidents will rarely happen, as men cognizant of the danger will be both amenable to discipline and as careful as circumstances will permit.

SECTION 23.

CARE OF INJURED.

It shall be the duty of operators, superintendents, or anyone in charge of any mine to keep at such place about the mine as may be designated by the inspector a stretcher, a woolen blanket, and a waterproof blanket in good condition for use in carrying any person who may be injured at the mine. Where more than 100 persons are employed, two stretchers, two woolen blankets, and two waterproof blankets shall be kept. At all mines an adequate supply of materials shall be kept readily accessible for the treatment of anyone injured and shall include the following in suitable quantity: First-aid outfits consisting of one extra-long gauze bandage with compress sewed in its center, one triangular bandage with methods of application printed thereon, two safety pins, and one card of instructions; large first-aid dressings for wounds; packages of sterilized gauze; assorted bandages; United States Army tourniquet; carbolated vaseline or boric acid ointment; packages of picric acid gauze; wooden or wire-gauze splints; packages of absorbent cotton; safety pins; shears; tweezers; aromatic spirits of ammonia; paper cups; first-aid book of instructions; soap; basins; towels. Furthermore, in all mines where 100 or more men are employed a first-aid corps shall be organized, consisting of the foreman or foremen, shift bosses, timekeepers, or other employees designated by the superintendent; and it shall be the duty of the operator or superintendent of the mine to cause the organization of such employees and to procure the services of a competent person to instruct the members of such first-aid corps from time to time, not less than once in every three months, in the proper handling and treatment of injured persons before the arrival of a physician.

For mines employing over 1,000 men the services of a resident physician are most desirable, and the committee strongly recommends that such be employed. It seems, however, too onerous a provision to be embodied in law.

This section was submitted to Maj. Robert U. Patterson, of the American National Red Cross, and is based somewhat on his suggestions. Certain comments of Maj. Patterson's are pertinent, as follows:

First aid is "what to do until the doctor comes" or "what to do in order to get the patient to the doctor in the best condition to be benefited by his professional skill." In other words, what it is proper for a layman to do to the injured person and what is not proper for him to do. Those practicing first aid have no business to invade the province of the physician. * * * For the purposes of first aid one needs: Sterile dressings, the means to stop hemorrhage, materials for temporary splinting or immobilizing broken bones, some suitable form of stimulant with which to treat shock, facilities for removing foreign bodies from the eye, mouth, nose, etc., bandages and pins to hold dressings in place, and something to use in the treatment of burns. A reference book is also useful; and if not precluded by cost, soap, basin, and towels can be included, simply for the use of those rendering first aid themselves, but certainly not for the patient. It should be clearly understood that the wounds of patients will not be washed, as this is not within the province of true first-aid treatment.

Maj. Patterson further recommends that each miner carry a small first-aid outfit of bandages and pins, as is done by soldiers of the

Regular Army. This is an excellent suggestion, but is perhaps better left to the discretion of the operator than embodied in law.

The set of first-aid supplies is put up by the first-aid department of the American National Red Cross especially for railroad, industrial, and mining work, suitable quantities of the several materials being packed in a heavy tin case and sold at a reasonable price.

SECTION 24.

MINE MAPS.

The operator of every mine shall make or maintain, or cause to be made or maintained by a competent mining engineer or surveyor, a clear and accurate map or maps, with sections, if necessary, showing clearly all the workings of such mine. At least once in every six months, or oftener, if necessary, the operator or superintendent of each mine shall cause to be shown clearly and accurately on the map or maps of such mine all the excavations made therein during the time elapsed since such excavations were last shown on such map or maps, and all parts of said mine that shall have been worked out or abandoned during said elapsed period of time shall be clearly indicated on said map or maps, and all underground workings shall be surveyed and mapped before they are allowed to become inaccessible. Such maps shall at all times be open to the examination of the inspector of mines or any of his deputies. In the event of the closing of a mine under conditions that will result in its workings becoming inaccessible the maps herein specified, or certified copies of them, shall be filed with the inspector of mines.

The object of this section is to require mine maps to be both accurate and intelligible, and to be kept reasonably up to date. It has not seemed advisable to require that a copy of all mine maps, together with all subsequent changes and corrections, shall be filed in the office of the inspector of mines, as it is not perceived that any great good would be accomplished thereby. The provision requiring that such maps shall be open at all times to the examination of the inspector or deputy is regarded as sufficient for the purposes of the act. However, in the event of abandonment of a mine, a condition that would probably render the maps inaccessible to the inspector, it is required that the maps, or copies of them, shall be filed with him.

SECTION 25.

FAILURE TO MAKE MAP—REMEDY.

Whenever any operator of any mine shall neglect or refuse to make such map of the workings of any such mine for a period of three months after the receipt of written notice so to do by the inspector or by any deputy, or shall fail to add or cause to be added to such map at least once in every six months representation of all excavations made within said period, then and in either of such events, the inspector is hereby authorized to cause a correct survey and map of such mine to be made at the expense of the operator thereof, the cost of which shall be recoverable at law from said operator as other debts are recoverable by law. The amount advanced by the inspector for making any map as provided in this section shall be considered as part of the expense of his office and shall be paid as such.

SECTION 26.

INFLAMMABLE MATERIAL.

It shall be the duty of the operator of every mine in which oils and other dangerously inflammable materials are used, to store such materials, or cause them to be stored, in a covered building kept solely for such storage, which building shall be at least 100 feet from any other building, shaft, tunnel, or other mine opening, and at least 300 feet from any powder magazine: *Provided*, That gasoline, naphtha, distillate, and fuel oils may be stored in a tank or tanks buried in the ground, which tank or tanks shall be provided with proper vents, and shall be placed at least 50 feet from any building, shaft, tunnel, or other mine opening, and at least 300 feet from any powder magazine: *And provided further*, That lubricating oils may be stored in a well-constructed, covered building, which shall be at least 30 feet from any building, shaft, tunnel, or other mine opening, and at least 300 feet from any powder magazine. No tank shall be installed from which liquid fuel is to be conducted by gravity to the point of combustion, unless there be installed between such tank and such point of combustion a simple and reliable cut-off valve which shall be capable of being reached and closed within 30 seconds from any point within the building in which such point of combustion is situated.

The man in charge of such building or tank or tanks, who shall be the superintendent or a person expressly designated by him, shall permit only sufficient oil or other inflammable material to be taken from such building or tank or tanks to meet the requirements of one day. If any oil or gasoline storage be so situated that leakage would permit the oil or gasoline to flow within the above-specified distances, means to prevent such flow must be provided.

Illuminating oil shall not be stored in the underground workings of any mine, except such quantity as is sufficient to meet the estimated requirements of the mine during the succeeding 24 hours. No more than 6 gallons of any one kind of lubricating oil shall be stored underground on any one level at any one time. No oil, candles, explosives, timber, or other combustible materials shall be stored at all in shaft stations or within 50 feet thereof.

Gasoline shall not be stored underground: *Provided, however*, That a tank containing gasoline and connected to the engine or other apparatus in which it is being used shall not be construed as a storage tank. No engine or other apparatus shall be filled with gasoline while underground.

Waste timber or old timber shall not be piled and permitted to decay in stations, drifts, crosscuts, or other open workings in the mine, but shall be removed from the mine as soon as practicable: *Provided, however*, That in stopes or other workings old timber may be buried in the filling material and permitted to remain in the mine. Empty boxes, wooden chips, paper, and combustible rubbish of all kinds shall be removed from every working place underground at least once in every 24 hours.

Timber storage sheds or any inflammable structure shall not be placed or permitted to remain within 75 feet of the shaft house or hoisting-engine house: *Provided, however*, That wooden headframes for hoisting and lowering may be erected and operated.

All inflammable material that may be stored in any existing house or structure erected over any shaft, tunnel, or other mine opening shall be immediately removed, and such inflammable material shall not be stored within 30 feet of the exterior walls of such house or structure now existing, or that may hereafter be built.

All oily waste and waste of any kind used in and about underground machinery shall be deposited in metal receptacles.

Calcium carbide shall be stored on the surface only in detached, waterproof, dry, and well-ventilated buildings, and shall be contained in the original metal packages not exceeding 100 pounds each. All such packages but one in such storage place shall remain sealed except that a new package may be opened when in the only other open package there remains less than 1 pound of calcium carbide. No calcium carbide shall be stored underground.

The storage of oils, gasoline, etc., in steel tanks buried in the ground, which is now general practice, has advantages that should recommend it to mine operators, as the oil is protected from freezing; in case of leakage the ground around the tank will prevent the oil from escaping, and in case of fire the inflammable material is entirely protected. In addition such storage has the recommendation of being the method most favored by the insurance companies. Mr. Edwin I. Atlee, president and treasurer of the Philadelphia Manufacturers' Mutual Fire Insurance Co., states that the requirements of his company on this subject are as follows:

The recommendations that we make in relation to oils, gasoline, etc., in connection with plants insured by us are governed somewhat by the yard spaces with which we have to contend. As to the storage of lubricating oils, we do not look upon them as hazardous, and it is the usual custom to store them in well-constructed buildings outside and 25 to 50 feet away from main buildings.

In the case of gasoline, fuel oils, naphtha, etc., we invariably require such materials to be buried in the ground, with proper vents, and not nearer than 50 feet to any building. Of course, if the yard space permits, we naturally require a greater distance. In no circumstances do we allow this class of oils to be stored above ground, and we will not permit installations in which such oils are conducted by gravity to the point of combustion.

On the provision that no oil be conducted by gravity from a storage tank to the point of combustion, J. R. Finlay has commented to the effect that if such a regulation had been in force at the Goldfield Consolidated at the time that he was general manager of that property, a \$150,000 fire would have been avoided. Although this particular fire occasioned no loss of life, so fortunate an outcome could not in general be expected.

The provision governing the use of gasoline underground permits the employment of the plumber's blow torch, the gasoline locomotive, and also the stationary gasoline engine if modified as to its tanks. The tanks of the latter two, however, must be filled above ground. Most makes of American gasoline locomotives are designed to permit this. The use of such locomotives is a relatively new thing in American mining practice. Some discussion regarding their safety appears in Chapter V. The committee considers the actual storage of gasoline underground in any quantity to be highly dangerous and therefore prohibits it altogether.

It is desirable that no lubricating or other oil be allowed to come into contact with timber at all, as oil-soaked timber is much more liable to burn. In the lubrication of cars especially the lubricant is

likely to be carelessly handled and spilled. Although finding it impracticable to embody its belief in an equitable provision in the law, the committee thinks that such lubricating should be carried on only in a rock drift or similar working.

Additional rules designed to reduce the danger of fire in and about mines appear in subsequent sections of this act. The terrible danger of underground fires is not perhaps fully appreciated, but the fearful calamity in the North Mount Lyell mine in Tasmania in 1912, when 42 men were killed, drew emphatic attention to it. The historic fires in the Anaconda, Calumet & Hecla, and Homestake mines are in the minds of all. These were especially destructive of property. The Anaconda fire is still burning and the expectation is that it will continue to burn for many years, or until all the combustible matter in the bulkheaded "fire stopes" has been exhausted. During 1911 the following fires, involving loss of life, happened in mines of the United States:

Details of fatal underground fires in mines in the United States in 1911.

January 14, 1911, underground fire in the workings between the Modoc and the Butte-Ballaklava mines, Butte, Mont.; 2 men smothered.

February 23, 1911, fire in Belmont mine, Tonopah, Nev.; resulted in death of 17 men.

May 5, 1911, 7 men killed by fire in Hartford mine of Republic Iron & Steel Co. at Negaunee, Mich.

August 23, 1911, fire in new shaft of Giroux Consolidated Mines Co., Kimberly, Nev.; resulted in 7 deaths.

The above list would be greatly extended if the fires resulting only in damage to property were added. We are now speaking solely of underground fires. Surface fires would constitute a further and long addition, and these may be as dangerous to the men underground as a fire originating in a stope or shaft station. Thus, in 1909, a fire destroyed the shaft crusher house of the London mine of the Tennessee Copper Co. Burning timber fell down the shaft and cut off the egress of the miners, who made their escape through another outlet of the mine, demonstrating emphatically the soundness of the legal requirement that a mine should be provided with more than one outlet.

The causes of mine fires are numerous. In the presence of excessively dry timber fire may be started by some trifling accident or piece of carelessness, and may spread with surprising rapidity. Burning candles left in stopes on the departure of a shift are a danger. Recognizing this, the Anaconda Copper Mining Co. has a corps of inspectors, "fire bugs" in the vernacular, to go through the stopes after the miners have gone. In the case of the Homestake fire, a piece of smoldering fuse has been designated as the cause. In metal mines,

blasting is a risk of minor importance, the conditions in this respect being different from those of a coal mine. We know of no authentic case where the flame of a blast has been responsible for setting timbers on fire. The short circuiting and overheating of electric wires is a common accident by which mine fires are started. On June 11, 1912 the pump room of the Ward shaft at Virginia City, Nev., was endangered by a fire caused by the short circuiting and exploding of an oil switch on one of the pumps. In this case no fatalities occurred and no great damage was done. In most cases mine fires are attributed to "causes unknown," which may be paraphrased as "undetermined carelessness."

The safeguards against underground fires are, in the main, those that should be taken against fire anywhere—namely, eternal vigilance and the exercise of common sense. Under the latter head come the clearing away of combustible rubbish and the avoidance of carelessness with matches, candles, and lamps. Experience has abundantly proved that a shaft should not be covered by any building at all, but where the severity of the climate creates the necessity for such it should be of incombustible construction, and combustible material should be kept out of it. The shaft itself, being the main communication with the mine, and being timbered as a rule, should be made as nearly fireproof as possible. Fortunately, many shafts are wet. When they are not they may advisably be equipped with a sprinkling system such as is installed in most of the modern factories of New England. This precaution may be especially advisable in the case of dry shafts in which creosoted timber is used. The cost of such an installation is moderate, and certain of the mining companies in the Lake Superior iron country have already adopted it. Although such an equipment is advisable, the committee has not considered its specification necessary except in one specific case (see sec. 39). This subject is further discussed in Chapter V.

The provisions for the removal of old timber from underground are intended to reduce the fire hazard to the lowest practicable minimum. Timber stowed away and well covered with gob or filling would not add greatly to the fire hazard compared with timber covered in place, as when a square-set stope is filled; and removal of the latter is, of course, impracticable. Such covered timber, however, will burn. This was found to be the case at the Mount Morgan mine, Queensland, where hardwood timber took fire and burned in filling material, as noted in the *Engineering and Mining Journal* of May 9, 1914. At the Copper Queen mine, in Arizona, also, all or almost all of the several fires occurring in recent years originated and continued burning for some time in filled stopes.

SECTION 27.

STORAGE OF EXPLOSIVES.

The term "magazine" as used in this section shall be held to mean and include any building or other structure or place in which explosives are stored or kept, whether above or below ground.

Sufficient explosives may be stored within a mine to meet the estimated requirements of such mine during the succeeding 24 hours, and an additional 24 hours' supply of explosives may be taken within the mine for the purpose of thawing the same in accordance with the provisions of rules 54 to 61 of section 49 of this act, but in no event shall any greater supply of explosives be taken into or stored in the mine than is required to meet the estimated requirements of the mine during the succeeding 48 hours.

No explosive shall be kept at any place within a mine where its accidental discharge would cut off the escape of miners working therein.

All explosives within the mine shall be kept in stout, tight boxes with hinged lids, from which the explosives shall be removed only as required for immediate use. It shall be unlawful to keep such boxes containing explosives near any track or electric conductors or in any manway, or to permit any grains or particles of such explosives to be or remain on the outside or about the containers in which such explosives are held. Black blasting powder and high explosives shall not be kept in the same box.

Not more than 75 pounds of explosives shall be kept in any one level at any one time, except that such explosives may be stored in an underground magazine, from which supplies required for immediate use shall be distributed to the various working places by an authorized and competent person or persons. Such underground magazine may consist of a separate drift or chamber, the walls of which shall be of fireproof material or of wood covered with sheet iron. The entrance to such underground magazine shall be kept securely locked, except when it has to be entered by the person or persons in charge thereof.

All explosives, except detonators, in excess of the temporary supply authorized to be taken into or stored in the mine shall be stored in a magazine aboveground, which shall be placed not less than 300 feet distant from any shaft, adit, or other mine entrance, boiler, engine house, habitation, public highway, or public railway: *Provided, however,* That in cases where the location of any mining property makes it impossible to comply with the provisions of this section the inspector may grant permission in writing to the operator of such mining property to place such magazine in some other place on such property, if, in the opinion of the said inspector, such location be not dangerous to the safety of the mine employees or the public.

Every magazine aboveground shall be fireproof and waterproof and shall be constructed of bullet-proof material. It shall be provided with mounds of earth, which shall be free from stones over 1 inch in diameter, and shall be not less than 2 feet thick, on such side or sides as are in line with any shaft, adit, or other mine entrance, boiler, engine house, habitation, public highway, or public railway, and which are not protected by natural features of the ground, and such mound of earth or intervening natural feature, or both, shall be of sufficient height so that a line drawn from the top of any wall of the magazine to any part of the shaft, adit, mine entrance, or structure to be protected, or to a point not less than 10 feet above the center of such public highway or public railway, shall pass through such mound of earth or intervening natural object. The floors of all such magazines shall be laid with sound boards, free from knots, tongued and grooved, and not to exceed 3 inches in width. All nails in the interior of the magazine shall be countersunk. The ground around such magazines shall be kept free from rubbish, dead grass, shrubbery, or other

encumbrances, and no person shall be allowed to loiter about such place. All electric wires in any magazine shall be inclosed in metal conduit and shall not be brought within 10 feet of the explosives stored therein.

No matches or fire of any kind shall at any time be permitted in any magazine. *Provided, however,* That candles or oil or gas lamps may be used for the purpose of illumination if properly inclosed. Magazines shall be ventilated, and the openings for ventilation shall be so screened that sparks of fire may not enter therein. Magazines shall at all times be kept clean and dry, and free from grit. Before any alterations are made to any part thereof all explosives shall be carefully removed and the magazine thoroughly washed out. All tools and instruments used in making repairs shall be of wood, copper, brass, or other soft metal or material. In no case shall nails or screws be driven into a magazine or into material that has once formed a part of a magazine, and all wooden parts discarded shall be burned in a safe place immediately.

All detonators shall be stored aboveground in a suitable magazine or magazines, properly protected against molestation: *Provided,* That a sufficient supply for the needs of the mine during 48 hours may be stored underground as heretofore stated. No detonator shall be stored within 100 feet of other explosives underground or within 300 feet of other explosives aboveground. No detonator shall be taken into any magazine containing other explosives. No fuses shall be capped with detonators in any magazine or in any other place where detonators or other explosives are stored, but special benches shall be provided at least 50 feet from such storage places, where all fuses shall be capped. Cap crimpers shall be furnished in sufficient quantity to avoid the necessity of crimping in any other way. No detonator shall be transported with other explosives except when made into a primer with such other explosive. All primers shall be exploded within 10 hours after making. Not more than 1,000 detonators shall be kept underground in any one level at any time.

Fuse shall not be stored underground for a longer period than 72 hours.

When supplies of explosives or fuse are removed from a magazine those that have been longest in the magazine shall be taken first. Packages of explosives shall be removed to a safe distance from the magazine before being opened, and no such packages shall be opened with any metallic instrument.

Any failure on the part of the operator of any mine coming within the provisions of this act to carry out and enforce any or all of the requirements of this section shall constitute a misdemeanor and shall be punished as hereinafter provided.

It would be desirable to prohibit absolutely the storage of explosives within the mine, but this prohibition would work a great hardship in many mining regions, and therefore the committee has sought to limit the quantity of powder or explosives that may be brought in and stored, and to limit the quantity that may be accumulated at any one place, and so to surround the storage of such explosives underground with safety requirements as to reduce the danger of accident to the minimum. The impracticability of requiring a central thawing house for explosives on the surface of the ground is discussed briefly in the remarks on rule 54 of section 49, and it is consequently necessary to permit one day's supply of explosives to be brought into the mine and to be thawing there while another is being used. Owing to the fact that caps may explode from a slight shock, a due regard for safety requires that they should not be stored in the

same magazine with other explosives but should be both stored and carried separately. Every effort should be made to prevent the caps and powder coming together until the very last moment.

The most suitable method of illuminating a magazine is by incandescent lamps with reflectors, set at some distance from the explosives. To require this, however, would work a hardship on mines that have no electric-light service. The portable electric lamp is equally safe, but is not yet sufficiently well developed to be practicable. The portable acetylene lamp is the most dangerous device for this purpose; the simple candle is a close second. The large acetylene lamp set some distance from the explosives is not very unsafe, but is not wholly reliable. For these reasons the committee has not cared to specify the mode of lighting magazines, nor to prohibit candles or oil and gas lamps if properly inclosed. It strongly recommends, however, that electric lighting be used.

The danger due to the presence of a powder magazine results from its faulty construction fully as much as in its improper location. The walls of such a building, therefore, should be constructed of light material and should be fireproof, waterproof, and bullet-proof. The Bureau of Mines, after considerable experimenting, has found that a bullet-proof magazine for storing explosives may be constructed with lean cement mortar, in the proportion of one part cement to six parts coarse sand, the walls containing a 6-inch thickness of such material, and the door and roof a 3-inch thickness. It was found that the greatest penetration of bullets, either metal-patched or soft-nose, when fired from a distance of 55 feet from a Springfield 0.30-caliber, or from a Winchester 0.401-caliber, was 3 inches. The two most favorable characteristics of this material are resistance to penetration of bullets and the ease with which the material will disintegrate when subjected to the force of an explosion. The same consideration, ease of disintegration, led to the requirement that the sides of a magazine in line with a shaft, etc., should be provided with mounds of earth rather than barricades of heavy timber, which might well be an additional source of danger.

Although the principle that the distance at which explosives may be stored from buildings, highways, etc., shall depend upon the quantity of explosives to be stored is a desirable one generally, it is not always possible of application to mining properties, where in many instances the entire width of the property may not exceed 300 feet. It is therefore necessary to lodge some degree of discretion in the inspector, although otherwise making the requirement exact.

A quantity and distance table for the storage of explosives, which has been submitted by Col. B. W. Dunn, chief inspector of the Bureau for the Safe Transportation of Explosives and Other Dangerous Articles, follows.

Quantity and distance table.

1. Quantity that may be lawfully kept or stored from nearest building, highway, or railroad.				2	3.	4.
Blasting caps.		Other explosives.		Distance from near- est build- ing.	Distance from near- est rail- road.	Distance from near- est high- way.
Number over.	Number not over.	Pounds over.	Pounds not over.			
1,000	5,000			<i>Feet.</i> 30	<i>Feet.</i> 20	<i>Feet.</i> 15
5,000	10,000			60	40	30
10,000	20,000			120	70	50
20,000	25,000		50	200	120	80
25,000	50,000	50	100	240	140	100
50,000	100,000	100	200	360	220	140
100,000	150,000	200	300	520	310	200
150,000	200,000	300	400	640	380	260
200,000	250,000	400	500	720	430	280
250,000	300,000	500	600	800	480	320
300,000	350,000	600	700	860	520	340
350,000	400,000	700	800	920	550	360
400,000	450,000	800	900	980	590	380
450,000	500,000	900	1,000	1,020	610	400
500,000	750,000	1,000	1,500	1,060	640	420
750,000	1,000,000	1,500	2,000	1,200	720	480
1,000,000	1,500,000	2,000	3,000	1,300	780	520
1,500,000	2,000,000	3,000	4,000	1,420	850	570
2,000,000	2,500,000	4,000	5,000	1,500	900	600
		5,000	6,000	1,560	940	640
		6,000	7,000	1,610	970	640
		7,000	8,000	1,660	1,000	660
		8,000	9,000	1,700	1,020	680
		9,000	10,000	1,740	1,040	700
		10,000	20,000	1,780	1,070	710
		20,000	30,000	2,110	1,270	840
		30,000	40,000	2,410	1,450	960
		40,000	50,000	2,680	1,610	1,070
		50,000	60,000	2,920	1,750	1,170
		60,000	70,000	3,130	1,840	1,250
		70,000	80,000	3,310	1,930	1,320
		80,000	90,000	3,460	2,080	1,380
		90,000	100,000	3,580	2,150	1,430
		100,000	200,000	3,670	2,200	1,470
		200,000	300,000	4,190	2,510	1,680
		300,000	400,000	4,670	2,800	1,870
		400,000	500,000	5,110	3,070	2,040

This section has been subject to criticism on the ground that in rough country, such as is found in many western States, the danger from snow slides is so great that underground storage becomes safer than storage in a surface magazine. The situation of a mine in a well-settled town has a similar effect. In such cases underground storage might be advisable, the preference being given to a magazine in some detached working, such as an abandoned adit or tunnel, of sufficient depth so that the explosion of the contents would not affect the surface, and so located and constructed that the fumes and gas from the explosion of the contents of the magazine may escape readily into the open air and not reach any part of the mine where men may be at work.

The committee appreciates that the provisions of this section are minute and severe, but deems it advisable to present an ideal method for the storage of explosives without supposing that it will be possible to enact into law the section in its entirety.

SECTION 28.

MARKING OF EXPLOSIVES, DETONATORS, AND FUSES.

It shall be unlawful for the operator or superintendent of any mine to permit the use within such mine of any explosive, or any blasting caps or detonators, or fuse, unless there shall be plainly printed or marked, in the English language, on every original package containing explosives the name and place of business of the manufacturer of such explosive, the date of its manufacture, and its strength; and on every original package containing such fuse the name and place of business of the manufacturer of such fuse, the date of its manufacture, and its rate of burning; and on every original package containing blasting caps or detonators the name and place of business of the manufacturer of such blasting caps or detonators and the date of their manufacture.

SECTION 29.

BLASTING.

Bosses or shot firers shall be in immediate charge of and responsible for blasting within the mine. It shall be unlawful to use anything but wooden tamping rods, with no metal parts, in tamping explosives or tamping material in the bore holes, and it shall be the duty of the bosses or shot firers to see that no iron or steel tools are used for tamping. Detonators of not less strength than No. 6, containing 1 gram of fulminating composition, shall be used in firing blasts. It shall be the duty of the mine foreman to fix the time of all blasting and firing. Bosses or shot firers and miners about to fire shots shall cause warnings to be given in every direction, and all entrances to the place or places where charges are to be fired shall be guarded, so far as possible, by men; otherwise by signs, which shall be such as will not fail to attract the attention of anybody passing.

The number of explosions in every blast, except in case of simultaneous firing or blasts in stopes, shall be counted by the man firing the same, and if the total number of explosions is less than the number of charges fired a report of the discrepancy shall be made as the superintendent shall direct. When a blast has been fired and it is not certain that all the charges have exploded, no person shall enter the place where such charges were placed within 30 minutes after the explosion.

Wherever possible, a charge that has failed to explode shall be exploded by inserting a new primer in the hole on the old charge and detonating such primer. When tight tamping^a has been used, or when for any other reason a new primer can not be inserted, no attempt shall be made to extract the explosive, but a new hole shall be drilled, which shall not be nearer to the original hole than 2 feet, and shall be pointed at such an angle as to eliminate all danger of its meeting or coming closer to the old hole than 2 feet, and such new hole shall be charged with a fresh charge of explosives and then detonated.

When electricity is used to fire shots, it shall be unlawful for any person knowingly to enter the vicinity of the place where such shots have been fired until the cable from the source of electrical energy to the face of the blast shall have been disconnected. It shall be the duty of the boss or shot firer to see that all such cables are disconnected immediately after such firing and to examine or direct the examination of such place where shots have been fired before any men are permitted to work therein. All miners shall immediately report to the proper authority the finding of any loose wires under or in the

^a In the publications of the Bureau of Mines the word "stemming" denotes the material used to confine a charge of explosive in a blast hole; the word "tamping" denotes the act of pressing or ramming this material in place.

rock loosened by such firing, and in such event the mine foreman or, in his absence, the shift boss or other properly constituted authority, shall at once order work to cease until such wires shall have been traced to their terminals.

It shall be unlawful to use electricity from any grounded circuit for firing shots. It shall be the duty of the boss or shot firer to see that special precautions are taken against the shot-firing cables or wires coming into contact with the lighting, power, or other circuits, or with any metal pipe lines. All portable devices for generating or supplying electricity for shot firing shall, when in the mine, be in charge of a boss or shot firer. No person other than a boss or shot firer shall connect the firing machine or battery to the shot-firing leads, and such connection shall not be made until all other steps preparatory to the firing of a shot shall have been completed. The primary or secondary batteries used for shot firing shall be provided with a suitable case, in which all contacts shall be made or broken, except that the binding post for making connections to the firing leads may be outside. These binding posts shall be completely covered with insulating material of a permanent character, such as hard rubber, fiber, etc., except at the points where the firing leads make connections with the binding posts. Such batteries shall be provided with a detachable plug or key without which the detonating circuit can not be closed, or provided with one or more safety contact buttons that are well countersunk or protected by a non-conducting housing. The plug or key shall be detached when not actually in use for firing a shot, and shall not, under any circumstances, pass from the custody of the boss or shot firer.

Electricity from light or power circuits shall not be used for firing shots in a mine, except where the electrical connections to such light or power circuits are made within an inclosed switch room, which shall be kept securely locked and shall be accessible only to the authorized boss or shot firer.

No blast shall be fired under circumstances likely to injure any person.

In drafting this section the committee has had the benefit of the criticism and advice of the experts of the Bureau of Mines and of the advice and suggestions of Mr. F. H. Gunsolus, manager of the technical division of the E. I. du Pont de Nemours Powder Co., of Wilmington, Del. Although the committee has availed itself largely of the criticism and advice so given, it alone is responsible for the section in its present form.

It has been recommended by explosives experts that no one be allowed to enter a working place where a misfire has occurred until the following day, it being stated that such a rule is now in force in some of the mines in the anthracite coal field. Although the committee is perfectly ready to agree to the superior safety of this recommendation, it is not willing to prescribe such a provision in this section because of the great impediment to mining operations that would result. The length of time (30 minutes) that is fixed by the section should be sufficient with good fuses, but a greater length of time may be adopted by operators, with a corresponding diminution of the liability to accident.

Loose wires may sometimes be found in the muck which are only electric fuse wires blown out by the blast, but a due regard for safety requires that the rule be laid down broadly.

The committee considered including in the law a requirement that there should always be two men present when a blast was to be set off by cap and fuse, but decided that this provision was too sweeping and would be unfair to many properties. It strongly recommends the practice, however, as an excellent safety precaution.

The committee has adopted the requirement that blasting caps or electric fuses of not less strength than No. 6 be used in firing blasts of explosives, to conform to the recommendations of the Bureau of Mines with reference to the use of permissible explosives, and in accordance with the advice of Mr. Gunsolus.

Although in late years the improvements made in gelatin or ammonia explosives have made them safer to handle, the improvements have likewise made them less liable to detonation from shock. It follows, therefore, that as a rule the stronger the detonator used the better the execution will be. Detonators of No. 7 and No. 8 strengths are being used to-day with these explosives to a great extent, and the committee feels that the superior safety and better results attained justify the prohibition of the use of detonators of less strength than No. 6.

The question of handling misfires is a difficult one. Drilling new holes is not always a safe expedient and is not always effective in exploding the misfire. Where there has been no tamping the charge is best shot over with a new primer, and although the committee does not care to recommend the nonuse of stemming, it appears from further experiments of the Bureau of Mines that, with the higher explosives, tamping is of less importance than at one time supposed.

Electric blasting in shafts is rapidly coming into favor and is to be recommended as regards safety. However, the unfamiliarity of many miners with that system, and some uncertainty as regards the delay-action detonators, without which the system is impracticable, renders the committee unwilling to make it mandatory.

A point on which practice differs in various mines is that of the preparation of fuses. At some properties the capping of the fuses is delegated to certain men; in others each miner prepares his own. The choice between the two methods may hinge on the quality of the labor available. If the intelligence of the miners as a whole is high, they may be trusted to cap their own fuses; otherwise, it is preferable to delegate this work to one or more competent men. The committee, in fact, would recommend this practice for all properties of a size sufficient to prevent its being a burden, say, those employing over 100 men. The proper performance of this operation should cut down the number of misfires and also reduce the liability to accident in handling.

SECTION 30.

HOISTING ENGINEER.

It shall be the duty of every superintendent of every mine having a hoisting engine to appoint and designate one or more men, who shall be able to speak and read the English language readily, to be known as hoisting engineers. At all shafts where men are hoisted or lowered such hoisting engineers shall be not less than 21 years of age, and at shafts where men are not so hoisted or lowered they shall be not less than 18 years of age. It shall be the duty of every superintendent to appoint as hoisting engineers men who are familiar with the details and working of a hoisting engine, and except in case of emergency to permit no one other than such duly appointed hoisting engineers to run such engine or hoisting machinery: except that, by and with the consent of the superintendent, specified apprentices may be taught the operation of the hoisting engine at such times and under such restrictions as the superintendent may determine to be free of risk to life and limb. Any superintendent failing to make such appointment of hoisting engineer, or knowingly appointing any hoisting engineer not qualified as above, shall be guilty of a violation of this act.

In large mines the superintendent might, in practice, delegate the appointing power to the master mechanic. Although such action is permissible, it would not operate to relieve the superintendent of the responsibility for the appointment that this section places upon him.

SECTION 31.

HOISTING.

The superintendent of the mine shall establish for each shaft rates of speed for the cages, skips, buckets, or other conveyances that shall not be exceeded in the hoisting or lowering of men, and he shall post a notice of such limitation in a conspicuous place near each hoisting engine: *Provided*, That the speed so permitted shall not be greater than 500 feet per minute in the case of shafts of less than 500 feet in depth, and not greater than 800 feet per minute in the case of shafts between 500 and 1,000 feet in depth, and in shafts of more than 1,000 feet in depth not more than one-half the speed normally employed in hoisting material: *Provided further*, That in the case of inclined shafts the classification herein made shall be determined by the measurement on their slope.

The superintendent of the mine shall determine the maximum number of men that in his judgment may safely ride on each cage, skip, bucket, or other conveyance used in the mine under his supervision and shall post in a conspicuous place near each shaft a notice stating the maximum number of persons so permitted to ride and forbidding the carrying of any greater number. At the beginning of each shift the mine foreman or shift boss, or some other responsible person appointed by the superintendent, shall be stationed on the loading platform at the top of the shaft and shall prevent any greater number of men than that permitted by order of the superintendent to enter upon or into any cage, skip, bucket, or other conveyance and shall remain at this station until the last man about to descend the shaft shall have entered the cage, skip, bucket, or other conveyance. And at the end of the shift the man in charge of work on each level of the mine from which men are to be hoisted shall post himself in the station of the shaft at that level and shall prevent any greater number of men than the maximum permitted by the superintendent of

the mine to enter upon or into any cage, skip, bucket, or other conveyance and shall remain in this station until the last man to ascend shall have entered upon or into the cage, skip, bucket, or other conveyance.

In every mine operated on two or more levels in which 100 or more men are employed underground and in which the men are hoisted or lowered by cage or other conveyance except a bucket, such cage or other conveyance shall be operated under the charge of a person appointed as conductor, and no person other than this conductor shall give any signal for the movement of the cage or other conveyance.

At every mine in which 100 or more men are employed underground, whenever men are being lowered or hoisted at the beginning or end of a shift, there shall be with the hoisting engineer an extra man competent to operate the engine in an emergency.

In hoisting or lowering men with a bucket the speed, except in the case of apprehended danger, shall not exceed 200 feet per minute when the bucket is within 100 feet of the surface, or 500 feet per minute in any other part of the shaft.

The superintendent of the mine shall be responsible for the enforcement of the provisions of this section.

The committee deems it necessary to discriminate among mines according to the depth of shafts operated. It is necessary to hoist and lower more rapidly in deep than in shallow shafts, and the equipment of the former is usually of a character to permit the increased speed without involving any unreasonable hazard. With depths of over 1,000 feet still more leeway must be given, and in such cases it has appeared unwise to fix any arbitrary rate of speed per minute. The committee inquired of 22 of the largest metal-mining companies of the United States respecting their practice. These companies reported for about 180 shafts, ranging in depth from 300 to 5,000 feet, a rough calculation of the number of men employed in them being about 53,000. One of these companies hoists men at 1,800 feet per minute, one at 1,500 to 1,700 feet, two at 1,200 feet, one at 1,100 feet, and two at 1,000 feet. With a single exception the shafts are in excess of 1,000 feet in depth. The practice reported by the remaining 15 companies indicates that the limits named by the committee are reasonable. In any case the safe speed of hoisting and lowering is determined, among other things, by the condition of the shaft. The committee simply fixes limits that must not be exceeded, and requires the mine superintendent in every case to name and post a definite rate to which the hoisting engineer is bound in a subsequent section. The committee recommends, however, that a speed of 800 feet per minute in hoisting and lowering men be not exceeded.

The other provisions of this section conform to the practice at the largest and best managed mines of the United States, and in the main are generally followed. The practice of having a second man as a "stand-by" of the hoisting engineer is general in the Lake Superior copper-mining region, but also obtains elsewhere. Its purpose is

obviously to provide control for the engine in event of the sudden disability of the engineer. The requirement is not onerous upon the operator, because there is usually some person, some oiler, or other assistant about the engine-room who can be assigned temporarily for this duty.

The committee has limited the requirement of such a second hoisting man and also the requirement of a cage conductor (cage tender, cage rider, cager, etc.) to the mines employing 100 or more men underground. This number has been fixed by the committee in a purely arbitrary way and is simply to carry out its idea of discrimination between large and small mines.

SECTION 32.

SAFEGUARDS AGAINST OVERWINDING.

The sheave carrying the hoisting rope shall be placed upon a headframe so designed as to resist a pull in the direction of the hoisting engine greater than the breaking stress of the hoisting rope employed. The headframe shall be of sufficient height to allow room for a set of automatic safety chairs, and also for a Humble hook in connection with the hoisting rope or some equally practicable device for releasing the hoisting rope in case of overwinding.

The operator of a mine employing more than 100 men underground shall install upon the headframe both a rope-releasing device and a set of automatic chairs to hold the cage, skip, or man car in case the hoisting rope is broken or released through overwinding. Such safety chairs shall be placed at such distance below the releasing device as will equal 3 feet more than the height from the bottom of the cage, skip, or man car to the clevis at its top. Immediately below the sheave a strong stop shall be put in to prevent the cage, skip, or man car from being drawn over the sheave.

The operator of a mine employing more than 100 men underground shall install in every shaft in which men are hoisted by cage, skip, or man car, a device which shall give a warning signal in the engine-room whenever the cage or skip in ascending reaches a point 100 feet below the collar of the shaft. This device shall be independent of the usual indicator or any other device directly connected with the hoisting engine.

Provided, however, That the rope releasing device and the warning signal required by the terms of this section need not be installed if the hoisting engine be equipped with a device that will automatically stop the engine if the cage, skip, or man car passes a certain point, and provided further, that such automatic stopping device be kept constantly in good working order.

This section, except its first paragraph, is limited to mines employing 100 or more men underground, and to those that employ cages, skips, or man cars. The extension of its provisions to all mines would be too sweeping, in the opinion of the committee, but conformity to its provisions in all cases is recommended; also, so far as practicable, in the case of mines where the hoisting is done by means of bucket. The committee intends in the terms of the first paragraph to include all mines.

SECTION 33.

DUTIES OF HOISTING ENGINEER.

The following rules shall be observed by every hoisting engineer employed within this State:

Rule 1.—It shall be the duty of every hoisting engineer to keep a careful watch over his engine and over all machinery under his charge.

Rule 2.—He shall at all times be in immediate charge of his engine, and shall not at any time delegate any of his duties to any other person, except to apprentices duly designated as provided in this act; provided, however, that nothing herein contained shall be construed to prevent any hoisting engineer from delegating to or sharing his duties with any other duly appointed hoisting engineer, or turning over the engine and machinery in his charge to any other such engineer at the end of his shift.

Rule 3.—He shall familiarize himself with and use all signal codes for hoisting and lowering as directed to be used in this act.

Rule 4.—He shall not run his engine unless the same is properly provided with brakes, indicators, and distance marks on hoisting ropes or cables, as provided in this act.

Rule 5.—It shall be the duty of the hoisting engineer to exclude every person from his engine-room, excepting any person or persons whose duties require their presence therein, and visitors authorized by the superintendent of the mine.

Rule 6.—He shall hold no conversation with anyone while his engine is in motion, or while attending to signals.

Rule 7.—He shall run his engine with extreme caution whenever men are being hoisted or lowered.

Rule 8.—He shall not hoist men out of, or lower men into, any mine or shaft at a speed greater than the rate posted in the engine-room by the superintendent of the mine.

Rule 9.—He shall inspect all hoisting machinery and safety appliances connected therewith, and all ropes and hoisting apparatus, when and as directed by the mine superintendent, and shall report to him any defects found therein.

Rule 10.—After any stoppage of hoisting for repairs or for any other purpose exceeding in duration one hour, he shall run a bucket, skip, cage, or other conveyance, on which no men shall ride, up and down the working part of the shaft at least once, and shall not permit the bucket, skip, cage, or other conveyance to be used for hoisting or lowering men until the hoisting machinery and shaft shall have been found to be in safe condition.

Rule 11.—He shall do no hoisting in any compartment of a shaft while repairs are being made in the said hoisting compartment, except such hoisting as may be necessary to make such repairs.

Rule 12.—He shall hand the bucket, skip, cage, or other conveyance either at the top or at the bottom of the shaft before turning over the charge of the engine to his relief at change of shift, or at any other time.

Rule 13.—Upon receiving the blasting signal the engineer shall answer by raising the bucket, skip, cage, or other conveyance a few feet and letting it back slowly; and then upon receiving the signal of one bell he shall hoist the men away from the blast.

Rule 14.—He shall familiarize himself with and carry out the requirements of rules 8, 9, 10, 11, 12, 18, and 19 of section 49 of this act.

Rule 15.—Any hoisting engineer or any person having in charge the hoisting machinery connected with the mine who shall wilfully violate any of the provi-

sions of this section, or any of the rules contained therein, or who shall wilfully violate any of the provisions of rules 8, 9, 10, 11, 12, 18, or 19 of section 49 of this act shall, upon conviction, be deemed guilty of a violation of this act and shall be liable to punishment accordingly.

Rule 16.—The superintendent shall post a copy of this section and a copy of section 31 in a conspicuous place on the door of the engine house.

These rules conform to the practice among the best conducted mines of the United States. The committee calls special attention to rule 13. Fatalities resulting from failure of the hoisting engine to work after the fuses of a blast have been lighted and the signal to hoist has been given are frequent.

SECTION 34.

HOISTING ROPES.

It shall be unlawful to use in any mine any rope or cable for hoisting or lowering either men or material, when such hoisting or lowering is done by any means other than human or animal power, unless such rope or cable shall be composed of metal wires, with a factor of safety determined as hereinafter set forth: *Provided, however* That such metal wires may be laid around a heap center.

The factor of safety of all such ropes or cables when newly installed in shafts less than 3,000 feet deep shall in no case be less than six, and shall be calculated by dividing the breaking strength of the rope, as given in the manufacturers' published tables, by the sum of the maximum load to be hoisted, plus the total weight of the rope in the shaft when fully let out.

It shall be unlawful to use any rope or cable for the raising or lowering of men when its factor of safety, based on its existing strength and dead load, shall have fallen below 4.5.

It shall be unlawful to use any rope or cable of the so-called 6 by 19 standard construction for the raising or lowering of men, either when the number of broken wires in one lay of said rope exceeds six, or when the wires on the crown of the strands are worn down to less than 65 per cent of their original diameter, or when the superficial inspection provided for in this section shows marked signs of corrosion: *Provided, however* That when such broken wires are reduced by wear more than 30 per cent in cross section, the number of breaks in any lay of the rope shall not exceed three.

The superintendent of a mine shall keep a record of every hoisting rope used at the mine or mines in his charge, noting the length and cross-sectional dimensions of the rope, the construction of the rope, the kind of core, the number of strands, the construction of the strands, the number of wires per strand, the class of steel of which the wires are made, the breaking stress of such steel, the breaking load of the rope, the name and address of the maker, the date of manufacture, the date of purchase, the date when put in use, the designation of the shaft and compartment in which the rope is used, the dates of resocketing, reclipping, reclamping, recapping, and short lining, the length of rope cut off at each such operation, the dates of reversing ends, and the date when discarded. A copy of this record shall be filed with the inspector of mines.

It shall be unlawful to use any hoisting rope after three years from the time of its first installment, irrespective of whether use of the rope in the interval has been continuous or intermittent, unless a piece be cut off from the socket end of said rope and subjected to an actual breaking test in the laboratory of a responsible rope manufacturer or a testing laboratory of recognized standing and shall be found thus to be above the minimum limit of strength as prescribed in this section.

Every hoisting rope whereof the hook for connecting with the skip, cage, bucket or other conveyance is made by means of a lapped or zinc-filled socket, must be

resocketed at frequent intervals, at least 6 feet of the rope being cut off, and every rope whereof the connection be made by clamps or clips must be reclamped or re-clipped with the same frequency as herein specified for sockets, at least 6 feet of the rope being cut off at each time: *Provided*, That if the expected rope life, based on previous experience, be less than 10 months the resocketing must be done every month, *And provided further*, That if the expected life be between 10 and 15 months, the resocketing must be done every 2 months; if between 15 and 21 months, the resocketing must be done every 3 months; if between 21 and 24 months, the resocketing must be done every 3½ months, and if over 24 months, the resocketing must be done every 4 months.

When a new hoisting rope is installed, it must be run for at least 10 trips under full load before it is used for lowering or hoisting men and after each resocketing, re-clipping, re-clamping, or recapping, every rope shall be similarly run for at least four trips before it is used for lowering or hoisting men.

All ropes shall be superficially inspected once in every 24 hours by some competent person designated for that purpose by the superintendent. It shall be the duty of the superintendent to cause an examination to be made whenever a rope is resocketed, reclamped, or re-clipped, by cutting off from the lower end of such rope a section not less than 6 feet in length and having such section carefully examined both exteriorly and interiorly for corrosion and breaks. If upon any inspection such hoisting rope or cable shall be found to be below the requirements set forth in this section, it shall be disused for such purpose forthwith, and any operator or superintendent using or permitting the use of such hoisting rope or cable for the purpose of hoisting or lowering men thereafter shall be deemed guilty of a misdemeanor and shall be punished as hereinafter provided.

Every rope used for hoisting or lowering men or materials shall be securely fastened to its drum or reel and when in use shall never be fully unwound; at least one full turn shall remain always on the drum or reel. The end of the rope attached to the conveyance in the shaft shall either be securely fastened within a tapered socket or else it shall be bound around an oval thimble and then fastened to itself by such number of clips or clamps as will develop at least 80 per cent of the strength of the rope and the rope connection shall be maintained at least at that point of efficiency.

Every hoisting rope shall be treated with oil or some suitable rope compound at least once every month. Such compound shall be chemically neutral and shall be of such consistency as to penetrate the strand and not merely cover the surface of the rope:

Provided, That the terms of this section shall not apply to the hoisting and lowering of men in shafts over 3,000 feet deep: *Provided further*, That the terms of this section shall not apply to the hoisting or lowering of water or other material in shafts used exclusively for that purpose and whereof no compartment is used for the hoisting or lowering of men. If any shaft exempted by this proviso has a compartment for pipes or any other purpose than hoisting, and repairs or the attention of men be required in such compartment, hoisting through the shaft must be suspended while the men are in it.

The depth of incline shafts shall be taken as the vertical depth measured from the shaft collar.

This section has been drafted as an attempt to generalize a multiplicity of complex factors without entering upon details that would necessarily be confusing, and indeed would be beyond the understanding of any but the expert.

A hoisting rope is subject to different strains during every wind. The committee has thought to allow for the maximum strains by

specifying a high factor of safety, namely, six, to be computed in a specified way.

In using the maximum safety factor of 6 and the minimum of 4.5 the committee offers these figures tentatively and emphatically urges reference to and consideration of the discussion of this subject in Chapter V. The figures adopted by the committee are lower than those recommended by the wire-rope manufacturers, especially with respect to shafts of less depth than 1,000 feet. The committee feels sure therefore that the figures that it recommends tentatively as the minimum impose no hardship whatsoever on mining operators. If there be any hardship it is for the cases of shafts 2,000 to 3,000 feet in depth. In order to assure itself respecting this, the committee communicated with the mining company that operates more shafts of that depth than any other, and found that that company has been in the habit of using factors in excess of those named by the committee. This information tended to remove doubt on that side of the question. On the other side of the question the committee is doubtful whether it has not let off too easily those miners who are operating shafts less than 1,000 feet in depth. Let it be reiterated that the respective figures of 6 and 4.5 are adopted tentatively and in the light of the considerations mentioned. And let it be emphasized that mining operators in their own interest are advised to conform to the specifications of the rope manufacturers as stated in Chapter V of this report.

With every wind a rope suffers some deterioration of strength. When this deterioration is such that the factor of safety, computed as specified, falls below 4.5 the rope must be condemned. This allows a loss of 25 per cent in strength as compared with what is required of the original rope. The committee puts a specific figure, 4.5, rather than a relative one, inasmuch as many mines make original installations of ropes having a safety factor of more than six.

There is no way of determining the actual strength of a rope except by cutting off a piece and breaking it with a measuring machine. Some enlightened mine managers cause this to be done in present practice. The enactment of the law that the committee proposes may lead to an extension of this commendable attention, but it is not to be expected that the majority of mine operators will take the trouble. However, inattention will be at their peril. If an accident should occur from rope breakage and it should be found by the inspector that the rope was below the permissible strength the operator would, on the face of things, be responsible for the accident.

The deterioration in the strength of a rope occurs in a variety of ways, for instance, repeated bending of the wires, wear of the wires,

and corrosion of the wires, but all of these find a final expression in broken wires. The rope commonly used for hoisting has 6 strands of 19 wires each, of which 12 are outside wires, 72 outside wires in all. These 72 come to the surface in every complete turn in the rope's construction, or in every "lay," as it is called technically. If in any lay there be six broken wires, it is required that the rope be condemned. The precise relation between the number of broken wires and the degree of wear of the wires to the strength of the rope has not been determined by any authority and perhaps is incapable of precise expression, but the committee, aided by the opinion of rope experts, conceives that a rope of the ordinary type exhibiting six broken wires would have lost *approximately* the strength that is permissible by this section.

Therefore a rope must be discarded either if it has fallen below a factor of safety of 4.5 *or* if it exhibit six broken wires in a single lay, but these are not alternatives that relieve the operator. If a rope be tested and be found to be below 4.5, even if it shows no broken wires, it must be retired anyhow.

There is not specified any minimum diameter of sheave, drum, or roller over which a given rope may be run, although such specification may usefully be made as a guide to good practice and for that purpose some rules are given in the discussion of this subject in Chapter V. From the standpoint of safety, however, such a provision is unnecessary, the effects of bad practice and misuse being automatically taken care of in this section. If a rope be run over sheaves that are too small or if it be improperly supported in an incline shaft, its strength will diminish just so much the sooner, and so will broken wires appear.

Rope experts are unanimous in the opinion that the severest strain on a rope is at or near the point where the hook or shackle is fixed to the rope, and that for this reason every rope should have a piece cut off from that end and be resocketed, reclamped, or reclipped at least every four months; but ropes put to a service so severe that their reasonably expected life is less than two years ought to be adjusted at the connection end more frequently. This process is of further advantage in changing every so often three other points of special deterioration, namely, the two points where the rope leaves the sheave and the point where it leaves the drum when the shaft conveyance is stationary in its most common position, usually at the shaft collar. Every time the rope is resocketed these three points, as well as the corresponding points at angle sheaves, are advanced a certain distance, that is, a new series of points in the rope is brought subject to maximum deterioration. Hence the provisions stated.

In this connection the following provision from the report of the Transvaal Commission is of interest:^a

82. The portions of a rope that should be most carefully examined will generally be known to the mechanical engineer from his experience with preceding ropes and the knowledge of why and where they deteriorated most. With respect to external wear the places in the rope that should be especially watched are those where contact with the pit-head sheaves or heavy guide pulleys occurs at acceleration or retardation periods of the hoist. These places are also likely to suffer more than any others from internal wear, except perhaps that portion of the rope near the skip or cage, which, although generally subjected to no rubbing wear, yet is exposed to the corrosive effects as well as to the bending and shock stresses. In addition to these positions attention must also be directed to that part of the rope which lies between the drum and the sheave when the load is at the bottom of the shaft, as also to those parts of the rope which come in contact with the flanges of the drum.

The enforced retirement of a rope after a certain period of service is a debatable point. Some mining companies have a rule to discard a rope after two and one-half years of use, others after three years, irrespective of what the appearance of the rope may be. On the other hand ropes are known in many cases to have given good service for more than three years. The committee has met the differences of opinion by not prescribing any time limit, but making compulsory a breaking test of a rope that has been in use for three years if any further use of that rope be contemplated.

There are a few very deep mines in the United States, especially the copper mines of Lake Superior, wherein it is a mechanical impossibility to comply with the terms of this section, especially as to factor of safety. The committee has consequently exempted from the terms of this section all mines deeper than 3,000 feet instead of attempting to complicate the section by special provisions. Mines that have to hoist from depths greater than 3,000 feet must necessarily be equipped with such heavy, powerful machinery, requiring constant and expert attention that their operators are bound to have proper hoisting equipment and to take proper care of it, and out of self-interest are sure to do that better than any law can require them to.

The committee has also exempted from this section all shafts used exclusively for the hoisting or lowering of water or material, and by exclusively is meant a shaft and not merely a compartment of a shaft. If an operator cares to risk the physical damage resulting from a rope breakage we see no reason why he should not do so, providing all possibility of hurting any man be eliminated.

^a Report of the Transvaal Commission on the use of the winding ropes, safety catches, and appliances in mine shafts.

SECTION 35.

CAGES FOR HOISTING MEN.

It shall be unlawful for the operator of any mine to permit the hoisting or lowering of men through a vertical shaft deeper than 300 feet unless an iron-bonneted safety cage be used for the hoisting and lowering of such men, but this provision shall not apply to shafts in process of sinking.

It shall be the duty of the operator to have all cages in which men are hoisted and lowered, used in such shafts over 300 feet deep, constructed as follows: The bonnet shall be of two steel plates three-sixteenths of an inch in thickness, sloping toward each side, and so arranged that they may be readily pushed upward to afford egress to persons therein, and such bonnet shall cover the top of the cage in such manner as to protect persons on the cage from objects falling in the shaft. The cage shall be provided with sheet iron or steel side casing not less than one-eighth of an inch thick, or with a netting composed of wire not less than one-eighth of an inch in diameter and not less than $3\frac{1}{2}$ feet in height, and with gates of not less than $3\frac{1}{2}$ feet in height and made of the same material as the side casing, either hung on hinges or working in slides, or with a bar in lieu of a gate, such bar being not less than $3\frac{1}{2}$ nor more than 4 feet above the cage bottom. *Provided, however,* That nothing herein shall be construed as requiring the use of such gates or bars on cages when men are not being hoisted or lowered thereon, or when the number of men thereon does not exceed 50 per cent of the maximum capacity of the cage, determined as provided in section 31. Every cage shall have overhead bars of such arrangement as to give every man on the cage an easy and secure handhold. Every cage shall be provided with a safety catch of sufficient strength to hold the cage or skip with its maximum load at any point in the shaft in the event that the hoisting cable should break.

The failure of the operator of any mine to comply with the provisions of this section within 90 days after its passage shall constitute a misdemeanor and shall be punished as hereinafter provided.

SECTION 36.

BOILER INSPECTION. COMPRESSED-AIR TANKS.

All boilers used for generating steam in and about mines shall be kept in good order, and the operator or superintendent shall have them examined and inspected by a qualified person, not a regular employee of said operator, as often as once in six months, and oftener if the inspector or his deputy shall deem it necessary. *Provided* that inspection by any boiler-insurance company in good standing shall be considered equivalent to an examination by such qualified outside person. The result of such examination, under oath of the person making such examination, shall be certified in writing by the operator to the inspector within 30 days thereafter. It shall be the duty of the operator to provide each boiler with a safety valve of sufficient area for the steam to escape, and with weights or springs properly adjusted and with a steam gage and water gages; and another steam gage shall be attached to the steam pipe in the engine house. All steam gages shall be placed in such position that the engineer or fireman can readily examine them and see what pressure is carried. All steam gages shall be kept in good order, and shall be tested and adjusted as often as once in every six months and their condition reported to the inspector in the same manner as the report of the boiler inspection.

Every receiver, tank, or other receptacle, except transmission pipe, used for storing compressed air at a greater gage pressure than 40 pounds per square inch, which has a capacity exceeding 6 cubic feet, shall be capable of withstanding a gage pressure 50 per cent greater than that normally allowed by the safety valve to exist in such receptacle. Every such receptacle shall be inspected with the same frequency and in the same manner as herein provided for the inspection of boilers. Every such receptacle shall be blown out at least once in every 24 hours, so as to remove all accumulations of grease, oil, or other material likely to cause an explosion. In no such receptacle shall the temperature be allowed to rise above 250° F.

It shall be the duty of the operator to carry out the provisions of this section, and failure to comply with the provisions of this section shall constitute a violation of this act.

The provisions of this section do not cover all the details of boiler installation and operation. The committee recognizes that many States now have boiler-inspection laws, which it is not intended to supersede. The purpose of the section is rather to furnish a general guide for such legislation.

In Chapter XI will be found the account of an accident at the Santa Gertrudis mine in which a number of men were asphyxiated underground as the result of a compressor or receiver explosion. This and other not infrequent accidents of the same nature suggest the advisability of prescribing regulations governing the installation and operation of compressors and their receivers, which shall reduce or eliminate the likelihood of explosion. It is difficult to formulate definite and quantitative rules which shall be practicable and fair, in the light of present knowledge on the subject. For this reason the committee makes general provision for inspection of receivers and prescribes some obvious safety precautions. The manner of operating the compressor itself and the more detailed precautions to be observed in regard to the receiver are left in the hands of the mine operators. The committee would recommend a close adherence to the best accepted practice in this regard.

For any pressures over 60 pounds, two-stage compressors are desirable, with an efficient intercooler to remove the heat of compression as effectively as possible; also a separator to remove oil and moisture. The cooling water for both the intercooler and the water jackets should be the coldest obtainable, and the rise in its temperature due to passage through the machine should be kept below a certain maximum, say 20° F. If the compressor is run continuously with a capacity of anything over, say, 500 cubic feet of free air per minute, an aftercooler and an oil-and-water separator should be installed between the compressor and the receiver. The receiver must be provided with a safety valve and should be subjected to a pressure test when new, and periodically thereafter, and if large enough to permit it, should be provided with a manhole in order to allow

thorough inspection and cleaning of the interior. The lubricant for the air cylinders should be of high quality in general, and particularly it should have a high flash point. The quantity used should be kept at a minimum. It is probably good practice to sluice the air cylinders periodically with soapsuds, which may be introduced through the oil cups, in order to remove deposits of lubricants. The danger of explosion is thus diminished in three ways: By the use of a receiver sufficiently strong; by keeping down the temperature; and by keeping at a minimum the accumulation of explosive material.

SECTION 37.

GUARD RAILS.

All machinery used in or about the mine that when in motion would be dangerous to persons coming in contact therewith, such as engines, wheels, screens, shafting, gears, and belting, shall be guarded by a covering or railing so as to prevent persons from inadvertently walking against or falling upon the same. The sides of stairs, trestles, and dangerous plank walks, gangways, and platforms in and around the mines shall be provided with hand and guard railing to prevent persons from falling over the sides. This section shall not forbid the temporary removal of a fence, guardrail, or covering for the purpose of repairs or other operations, if proper precautions be used, and if the fence, guardrail, or covering be replaced immediately thereafter.

It shall be the duty of the operator to carry out the provisions of this section, and failure to comply with the provisions of this section shall constitute a violation of this act.

SECTION 38.

WOMEN AND CHILDREN IN MINES—EMPLOYMENT PROHIBITED.

No woman or girl, and no boy under the age of 16 years, shall be employed or permitted to work underground in any mine; and it shall be unlawful for any operator to employ such persons within a mine. Before any boy shall be permitted to work in any mine he shall produce to the operator, superintendent, or mine foreman thereof an affidavit made by the parent, guardian, or next of kin of said boy, duly verified, containing a statement that he, the said boy, is at least 16 years of age. Any violation of, or failure to comply with, the provisions of this section shall constitute a misdemeanor, and shall be punished as provided in section 52 of this act.

Provided, however, That nothing in this section shall be construed to prevent the employment of women, or children under 16 years of age, in the offices or buildings connected with a mine.

SECTION 39.

TWO OPENINGS TO SURFACE.

It shall be the duty of every operator of every mine, except as hereinafter provided, to maintain at least two outlets to the surface from such mine, or an underground communicating passageway between every such mine and some other neighboring mine, so that there shall be at all times at least two distinct and available means of access to the surface to all persons employed in such mine. Such outlets shall not be less than 100 feet apart and there shall be

between them a space not less than 50 feet in width free of buildings or inflammable structures or material.

Where two openings to the surface shall not have been provided as aforesaid, it shall be the duty of the inspector to order in writing, served upon the operator or superintendent of such mine, a second opening to be made without delay by the operator of said mine, and in the event of the operator of such mine failing forthwith to commence and prosecute the making of a second opening within 20 days after the service of said order, or in the event of the inspector deeming any mine having only one such opening to be dangerous to the lives and health of those employed therein, it shall thereupon be the duty of such inspector forthwith to institute an action for an injunction to close said mine as provided for in section 12 of this act.

Provided, however, That the above requirements shall not apply in the case of (a) shafts or mines in process of being connected, to comply with the terms of this section; (b) shafts, winzes, adit levels, tunnels, and drifts to prospect for and develop mineral substances, but not for the extraction of mineral substances, except such as may be extracted in the course of such prospecting and developing work; (c) any mine in which one of the shafts or outlets shall have temporarily become unavailable for the persons employed in the mine, and in which every effort is being made by the operator of the mine to open such temporarily unavailable outlet, and provided the same is not, in the opinion of the inspector, dangerous to the life and health of those employed therein; (d) mines having workings less than 100 feet deep and extending less than 500 feet from the shaft in any direction, but not mines opened primarily by an adit level or tunnel; and (e) mines opened by an adit level, tunnel, or drift less than 1,000 feet in length; and provided further, that mines opened by an inclined shaft of less than 20° angle from the horizontal shall be considered for the purpose of this section and act as equivalent to a mine opened by an adit level, tunnel, or drift.

Provided, further, That any prospecting or development property opened by a timbered shaft and exempt under exception b from providing two outlets to the surface shall not permit more than 50 men to work underground at any one time, unless such shaft be provided with a water-sprinkling system.

The purpose of this section is to compel mine operators to have two outlets to every mine in regular operation. The necessity for such a requirement is amply illustrated by experiences wherein men have been trapped underground by fire, flood, caving of outlet, etc. In many cases catastrophes have been averted by the existence of a second outlet for escape.^a It is, of course, impossible to have two outlets to a mine that is simply in process of being opened; that is, where shaft sinking is in progress and the ore body is being opened, and also during the time while the second outlet is being provided. This is the reason for exceptions a and b. Exception c is sufficiently obvious. Exceptions d and e are introduced in order to prevent the terms of this section from being too onerous. The perfection of the conditions of safety demands, without doubt, the provision of two outlets in every mine, but so drastic a requirement would probably prevent many small mines from being operated at all. In mines of moderate depth of shaft or moderate length of adit level or slope it

^a See account of fire at Copperhill, Tenn., described in Chapter XI of U. S. report.

is conceivable that escape might be made so quickly that certain dangers might be avoided. Exceptions *d* and *e* have that possibility in view. The depth and distance prescribed are, of course, purely arbitrary.

The committee recognizes that exception *b* is not a wholly satisfactory provision. Under its terms a large property might be developed extensively for several years and employ a large number of men who ought not to be subjected to the hazard involved in the lack of two outlets to the surface. It was thought that it might be possible to limit the number of men employed by such a development company, but application to specific cases showed such a restriction to be undesirable. It might have been prohibitive of development, for instance, if the Tamarack company had been required to sink two of the expensive shafts involved before permitting extensive lateral development. The committee has therefore contented itself with providing protection against shaft fire with a sprinkling system; there seems to be no practicable way of providing against the danger of men being cut off by caving or flood.

The requirement for a sprinkling system contemplates some arrangement of pipes into which water can be turned so as to spray the shaft interior. Such a sprinkler may or may not be automatic. An automatic sprinkling system, which would come into operation as soon as the temperature passed above a certain point, offers many advantages, but in addition to being practically untried for the purpose considered, it also involves a definite disadvantage, namely, that in an upcast shaft it may reverse the direction of ventilation at the wrong time. This objection would not, of course, be present in the case of a mine with a single outlet, for which the sprinkler is here prescribed, but there would remain the likelihood that if another shaft were sunk later the automatic sprinkler would not be removed, and if the old shaft turned out to be an upcast the sprinkler might be a menace. If it were a downcast, on the other hand, the sprinkling water would only accelerate the ventilating current and not reverse it. It is not known just how dangerous a reversal of current by an automatic sprinkler would be. Accounts of fires in Chapter XI indicate how serious this reversal may be when brought about after a fire has gained some headway. An automatic sprinkler is supposed to extinguish a fire soon after it starts, and when events proceed as contemplated there should not be enough smoke or gas thrown back into the mine workings to be dangerous to the men underground. There would, however, be always the possibility of some failure or hindrance that would delay the action of the sprinkler, with serious results. The committee therefore does not require an automatic sprinkling system, and furthermore hesitates to recommend it until more data on performance are available.

SECTION 40.

OPENINGS THROUGH OTHER MINES.

When a communicating outlet shall have been established by agreement between contiguous mines or mines not contiguous, it shall be unlawful for the operator of either mine to close the same without the consent of both the other operator, or owner, and of the inspector of mines. When operators of such mines have by agreement established underground communication between said mines as an escapement outlet for the men employed in both, it shall be the duty of each operator to cause such communicating outlet in each operator's mine to be inspected at least once in every seven days, and it shall be the duty of each operator to see to it, within his respective mine, that the same is kept clear of every obstruction to travel and that intervening doors, if any, shall be kept unlocked and ready at all times for immediate use.

In the event of failure or refusal on the part of one operator to keep such opening in safe condition, the other operator shall have access thereto for the purpose of repairing and maintaining the same: *Provided, however,* That when such an outlet shall have been established, each operator, unless it shall have been otherwise provided by agreement, shall pay a fair proportionate share of keeping such opening in such condition that men working in such mines may have access to the surface thereby: *Provided further,* That in the event of either operator desiring to abandon mining operations, the expense and duty of maintaining such communication shall devolve upon the party continuing operations and using the same: *Provided further,* That in case one of such mines shall cease or suspend operations and there is danger of the mine still in operation being flooded by reason of the existence of such communicating outlet, the operator of such mine still working shall have the right to close such outlet upon giving notice to the owner or operator of the adjoining mine and to the inspector of mines.

SECTION 41.

PROVISIONS AFFECTING MINES HAVING ONLY ONE OUTLET.

In every mine where, under the provisions of section 39 of this act, only one outlet is required and where a single shaft affords the only means of ingress or egress to persons employed underground, such shaft if more than 200 feet deep shall be divided into at least two compartments. One of said compartments shall be set aside for use as a ladderway and no hoisting conveyance shall be allowed therein. Whenever such ladderway compartment shall be covered by a nonfireproof building, it shall be the duty of the operator of said mine to cause said ladderway to be securely bulkheaded at a point at least 25 feet below the collar of the shaft; and below this bulkhead a passageway shall be driven to the surface so as to have its outlet in no case less than 30 feet beyond the walls of the building covering the main shaft. The said passageway shall be equipped with a ladderway when necessary, as provided in rules 35 to 41 of section 49 of this act, and shall be kept in good repair and shall afford an easy exit in the event of fire. Every mine opened by adit level or tunnel or by an inclined shaft or slope of less than 20° angle from the horizontal, which is less than 1,000 feet in length, shall have a similar side outlet. A failure on the part of the operator of any mine coming within the provisions of this section to carry out or cause to be carried out the provisions of this section shall constitute a violation of this act.

This section is intended to cover cases that are not reached by section 39 or, in other words, the exceptions to that section. See also remarks on rule 37, section 49.

SECTION 42.

PROTECTION OF OUTLETS AGAINST FIRE.

It shall be unlawful for the operator of any mine after the passage of this act to erect any combustible structure over the shaft, tunnel, or other mine opening, except headframes necessary for hoisting from such shaft or other mine opening, and the hatch or door necessary for closing such shaft or other mine opening. *Provided, however,* That a housing of noninflammable and fireproof material may be erected over any shaft, tunnel, or other mine opening to protect the men working at such point.

It shall be the duty of every operator to provide every adit, tunnel, inclined shaft, or slope of less than 20° angle from the horizontal, the mouth of which is covered by a building or house of any kind, with a door near the mouth of such adit, tunnel, inclined shaft, or slope of less than 20° angle from the horizontal that can be closed from outside of the building by a pull wire or cable in the event of fire.

In every timbered mine in which more than 100 men are employed there shall be in each drift or other working leading from any shaft used as a manway a metal or metal-covered door suitably hung at a place in the drift or other working not more than 75 feet distant from the shaft from which such working leads. Such doors shall be so set that when closed they may be quickly made airtight, and for the purpose of sealing them there shall be kept in close proximity to each door a suitable quantity of moist earth or moist clay. Such door must swing inward toward the shaft and no such door shall be fitted with any catch that will prevent its being readily pushed open by a man from the other side.

The committee recognizes the difficulty in mountainous regions of keeping adit portals, etc., free from snow, a condition that leads to the housing of such portals and to connecting them with covered passages, which latter is prohibited by section 39 of this act. It would not be sufficient alone to require the making of such buildings fireproof and noninflammable, as fire anywhere in such a group of buildings might have its smoke drawn underground by a strong indraft.

The purpose of providing fire doors is to isolate a shaft used as a manway from smoke in case of a fire underground. Their use is so novel to American mining practice that the committee does not at this time call for them except in those mines in which 100 men or more are employed underground, but such doors are recommended in all timbered mines. They may be installed in a simple way and at relatively small expense. A further discussion of this subject will be found in Chapter V.

SECTION 43.

LADDERWAYS AND LADDERS.

It shall be the duty of the operator of every mine to provide, in addition to any mechanical means of ingress or egress, at least one means of outlet for the miners by means of ladders from the lowest workings of the mine to the surface. All ladders and ladderways constructed after the passage of this act shall be built as prescribed in rules 35 to 42 of section 49 of this act. All ascending and descending manways through stopes, and every shaft, winze, raise, or incline steeper than 35 degrees from the horizontal, through which men are obliged to pass, shall be provided with ladders and ladderways as specified in this section:

Provided, however, That where the slope of the working place is such as to permit the installation of stairways that can be easily and safely traversed, such stairways may be substituted for ladders.

Every exit or outlet from a mine shall be marked with signboards plainly showing the direction to be taken wherever more than one course is possible: *Provided, however,* That no signboards shall be necessary where the exit or outlet does not branch or fork.

Every such exit or outlet shall be marked by colored electric lights wherever signboards are required, as herein specified, and an electric lighting circuit is available within 25 feet. Such lights shall have a color distinct from all other underground lights.

Relative to this section, attention is invited to the committee's remarks regarding rule 37 of section 49.

SECTION 44

VENTILATION.

The operator of every mine, whether operated by shaft, slope, tunnel, adit, level, or drift, shall provide and maintain for every such mine a good and sufficient amount of ventilation for such men and animals as may be employed therein, and shall cause an adequate quantity of pure air to circulate through and into all the shafts, winzes, levels, and all the working places of such mine.

A mining law should be, undoubtedly, more specific with respect to the insurance of proper ventilation, but the conditions existing in the several mining districts of the United States are so diverse that the committee has not deemed it wise to attempt a generalization specifying the exact degree of ventilation that shall be provided. In drafting special State laws attention should, however, be given to this subject.

Fatalities resulting from asphyxiation by gases emanating from the discharge of explosives in mines, or parts of mines, in which there is inadequate ventilation are numerous in their occurrence and considerable in the aggregate. Thus, in the mines of the Province of Ontario, Canada, in which approximately 9,500 men are employed, 3 men lost their lives from this cause in 1911 and 5 in 1912. The mining regulations in the Transvaal provide that in metal mines sufficient air shall be provided so that any sample of air taken under normal working conditions from any part of the mine not less than one hour after blasting shall contain not more than 20 parts in 10,000 of carbon dioxide or more than one part in 10,000 of carbon monoxide or any practicably determinable amounts of the oxides of nitrogen, NO and NO₂.

A further discussion of this subject appears in Chapter V.

SECTION 45.

SANITATION.—DRY CLOSETS, DRINKING WATER, CHANGE HOUSES, ETC.

It shall be the duty of the operator of every mine, for the purpose of improving the sanitation thereof and preserving the health of those employed therein, to provide dry closets, water closets, or closet cars upon all main work-

ing levels for the use of all men employed in the mine. At least one such closet shall be provided for every 25 men employed within the mine. Ready means of access to each such closet shall be provided by the operator. No closet shall be constructed without adequate provision for the effectual cleansing and removing of the contents thereof, which shall be removed and disposed of at least once in every day. It shall be the duty of the mine foreman to cause each dry closet to be supplied with some disinfectant or deodorizer to be sprinkled upon the contents thereof. It shall be the duty of all men employed within any mine where such closets are provided to use such closets exclusively when in the mine, and the neglect or failure of any man employed in a mine to use such closets when provided shall constitute a misdemeanor. The neglect or failure of the operator of any mine to provide closets as required by this section shall constitute a misdemeanor: *Provided, however,* That this section shall not apply to any mine where the operator or superintendent prefers to permit the men to go to the surface, and requires the men so to do.

Every stable or other place underground used for the housing of mules, horses, or other animals shall be thoroughly cleaned and the waste contents thereof removed to the surface at least every 24 hours.

It shall also be the duty of the operator of every mine to provide a good quality of drinking water for the use of all men employed in the mine, a supply of which shall be provided on each main working level, and it shall be the further duty of the superintendent to cause such supply of drinking water to be adequately protected from contamination by dust and from promiscuous drinking from the supply vessel on the part of the men.

It shall be the duty of the inspector of mines to see that the provisions of this section are complied with, and in the event of noncompliance to institute the proper proceedings under section 52 of this act.

The operator of every mine employing more than 50 men underground shall provide a dressing room or a change house for the purpose of drying the clothing of the persons employed in and about the mine, and such dressing room or change house shall be provided with adequate means of heating and lighting. Such dressing room or change house shall be available to the men, free of cost, at all reasonable hours.

Every person employed in a mine who damages or misuses, or fails to use when necessary, any appliances for the prevention of dust, fumes, or smoke, or any other sanitary appliance provided by the operator shall be deemed guilty of an offense against this act.

SECTION 46.

ROOF INSPECTION.

In all mines where stoping is done by the opening of chambers, the roof thereof being supported only by the walls of the chambers, or by pillars, it shall be the duty of the superintendent of the mine to detail a competent man to make a frequent inspection of the roof of those parts of the mine where men are employed, and said man so detailed shall be charged with the duty of dislodging any slabs of rocks in said roof that have become loose. While such dislodgment is being effected, the floor of the stope immediately beneath such loose rock shall be fenced off or otherwise adequately guarded: *Provided, however,* That it shall be the duty of every miner to care for the roof of the place where he is working.

It shall also be the duty of the superintendent of the mine to cause frequent inspection to be made by a competent person detailed for such purpose of the roofs of stopes, inclined shafts, inclined winzes, and other workings, and of the

sides of shafts and winzes when any of these are used as traveling ways, and of the roofs of all drifts, adit levels, tunnels, and gangways.

The first part of this section has particular reference to the working of mines in great open chambers, where the miners will be stoping at the sides thereof, and where it is entirely impracticable to require the miners to care for, or to observe the dangerous condition of, the roof of such chamber through which they are compelled to pass in order to reach their individual working places. Such methods of working prevail, for example, in the lead district of southeastern Missouri and in the Joplin zinc district, and in the former, at least, the safety of the roof is provided for as prescribed in this section. Where the roof is so lofty as not to allow satisfactory examination by the aid of the ordinary mine light, some more powerful illuminating device should be employed. Portable electric and acetylene lamps are available which cast a brilliant concentrated light for some distance. The use of such apparatus should be insisted upon.

It should unquestionably be required that the miner care for his working place, as the special knowledge that is acquired by familiarity in working a given place should result in the most careful and accurate inspection. Supervision will be exercised by the foreman or boss in passing on the miner's care of his roof, and constant failure to keep his roof and walls safe should result in his discharge. The miner can not possibly, however, be held responsible for the condition of the gangways through which he is compelled to pass, and the operator should be held responsible therefor.

SECTION 47.

SAFETY PILLARS.

No stoping shall be done within 20 feet of a shaft that is used for hoisting men or material; *Provided, however,* That stoping may be done within 20 feet of a shaft if said shaft is to be abandoned and the inspector of mines has been so notified in writing. The failure of the operator to observe the terms of this paragraph shall be deemed a violation of this act.

No stoping shall be done within 10 feet of the boundary line of a mining property.

Provided, however, That on the application of either owner of adjoining mines the inspector may give permission in writing to either or both owners to weaken, cut through, or work such pillars if, in the opinion of the inspector, the same will not be dangerous to the lives of those employed within either of said mining properties. Such consent, or a copy thereof, shall be filed in the office of the inspector. The failure of the operator of either or both of such adjoining mining properties to observe the provisions of this section shall be deemed a violation of this act.

Provided further, That nothing in this section shall be construed as compelling an operator to leave pillars along the side lines of his claim or claims when engaged in extracting ore from beyond said side lines in the exercise of his extralateral rights.

SECTION 48.

INTOXICATING LIQUOR PROHIBITED IN MINES.

Whoever shall, while under the influence of intoxicating liquor, enter any mine, or any of the buildings connected with the operation of the same where miners or other workmen are employed, or whoever shall carry intoxicating liquors into the same, shall be deemed guilty of an offense against this act, and upon conviction shall be punished accordingly.

Provided, however, That nothing herein contained shall prevent the carrying of any alcoholic spirits or liquor into such mine or buildings for the purpose of administering to anyone injured therein.

SECTION 49.

GENERAL RULES.

Rule.	Subject.
1.	GENERAL SAFETY PRECAUTIONS.
2-4.	FOREMEN'S DUTIES.
5-6.	CANDLES.
7.	FIRE FIGHTING HELMETS.
8-10.	CAGES.
11.	HOISTING WHILE SINKING SHAFT.
12.	DEEPENING SHAFT—PROTECTION.
13.	WHIMS.
14.	CROSSHEADS.
15-16.	SIGNALS.
17.	PUNISHMENT FOR INTERFERENCE WITH SIGNALS.
18-20.	SIGNAL CODES.
21.	CLEANING MANWAYS.
22.	FIRE PROTECTION.
23-25.	TIMBERING.
26.	FENCING DISUSED WORKINGS.
27.	PENALTY FOR DESTROYING FENCINGS AND COVERINGS.
28-29.	LIGHTING.
30-31.	PLACES OF REFUGE.
32-34.	PROTECTION AGAINST WATER.
35-42.	LADDERS AND LADDERWAYS.
43.	ENFORCEMENT OF RULES 35 TO 42.
44.	SUMPS.
45.	STOPES.
46-48.	WINZES OR RAISES.
49-52.	SHAFT PROTECTION.
53.	OILING CAGE SAFETY CATCHES.
54-61.	EXPLOSIVES—THAWING AND HANDLING.
62-63.	FUSES.
64.	REPORT OF PERSONAL ACCIDENTS.
65-69.	GENERAL RULES.

The following general rules shall be observed in every mine :

GENERAL SAFETY PRECAUTIONS.

Rule 1.—The operator and superintendent of every mine shall use every precaution to insure the safety of the workmen in the mine in all cases, whether provided for in this act or not.

FOREMEN'S DUTIES.

Rule 2.—Whenever a mine foreman can not personally carry out the provisions of this act, so far as they pertain to him, the superintendent shall authorize him to employ a sufficient number of competent persons to act as his assistants, who shall be subject to his orders and shall be known as "assistant mine foremen," and they shall be under the direct supervision of the mine foreman and shall carry on the duties of the mine foreman as directed by him and as prescribed in section 22 of this act.

Rule 3.—The mine foreman shall have charge of carrying out or directing the carrying out of his duties as prescribed in section 22 of this act; and any superintendent who shall direct or cause a mine foreman to disregard the provisions of this act shall be amenable in the same manner as the mine foreman.

Rule 4.—The mine foreman shall see that all dangerous places are properly fenced off and proper danger-signal boards are so hung on such fences that they may be plainly seen.

CANDLES.

Rule 5.—No candle shall be left burning in a mine or any part of a mine when the person using the candle shall depart from his work for the day.

Rule 6.—Where candle illumination is used underground metal sconces shall be provided at all timbered stations where candles must be kept burning, and it shall be unlawful to place or keep lighted candles in such places except in metal sconces.

Many fires underground, some of them disastrous, started by carelessness in leaving burning candles in dangerous places, emphasize the great importance of rules 5 and 6. The increasing use of the acetylene lamp introduces a new fire hazard. When the contents of the lamp bottoms are thrown out there may be unspent carbide therewith. This in a wet place will generate acetylene. Care should be taken therefore that carbide seemingly spent be not thrown where it may be a menace, especially nowhere near a magazine or any explosives outside such magazine.

FIRE-FIGHTING HELMETS.

Rule 7.—The operator or superintendent of a mine employing more than 50 men underground shall provide and keep in a readily accessible place at least two fire-fighting helmets or sets of breathing apparatus to be used in case of emergency. If such helmets or breathing apparatus be of the self-contained type, they shall not be used otherwise than in practice by anyone who does not thoroughly understand their operation or who shall not have had at least 10 hours' training in their use under a competent instructor.

The committee has not desired to specify any particular kind or make of apparatus to be provided as contemplated by the rule. If oxygen helmets be selected, it will be necessary to train men in the use of them and to provide for frequent inspection of the apparatus to insure its being in good working order when needed. The purpose of the committee is to require merely that some form of fire-fighting helmet, even if it be only a homemade affair, shall be always on hand. Such a homemade helmet devised at the Anaconda property is described in the *Engineering and Mining Journal* of October

10, 1908. It consists of a canvas hood on a wire frame, drawn close at the neck with a pucker cord. A small hole is cut opposite the eyes of the wearer. A short length of hose attached to the back can be connected to a longer hose from the compressed-air line. The flow of air past the face of the wearer and out the hole keeps out gases and acts as a cooling agent. These helmets have proved eminently serviceable and efficient. Another homemade helmet was used at Cananea, Mexico, by men working in a flue from the smelting plant.

CAGES.

Rule 8.—At all mines where hoisting is done by cage from two or more levels a man shall be employed whose duties shall be to load and unload the cage and to give the signals to the hoisting engineer. The superintendent shall be responsible for the enforcement of this rule.

The conductor, cage tender, or cage rider required by the terms of section 31 shall, when men are being hoisted and lowered, see that the gates or bars of the cage are closed before giving the signal to move the cage and shall be responsible for their closing.

Rule 9.—It shall be unlawful for any person to ride upon any cage, skip, or bucket that is loaded with tools, timber, powder, or other material except for the purpose of assisting in passing such material through a shaft or incline, and then only after a special signal has been given.

It has been the desire of the committee to draft a rule that would be workable in practice and that would not be violated because of unnecessary stringency. The desirability of having tools, powder, and other materials hoisted and lowered separate from the men will hardly be disputed. This rule will not prevent a miner from riding with his pick or with any other tool, as in such case the cage would not necessarily be loaded with tools, etc. A careful mine foreman or superintendent will not only see that cages are not overcrowded, but will prohibit the carrying of tools on the cages by the miners, save when absolutely necessary.

Rule 10.—When tools, timber, or other materials are to be lowered or hoisted in a shaft, their ends, if projecting above the top of the bucket, skip, or other vehicle, shall be securely fastened to the hoisting rope or to the upper part of the vehicle, and all tools, timber, or other materials loaded upon a cage shall be securely lashed before being lowered or hoisted, for which purpose a rope at least 12 feet long shall be kept on the cage: *Provided, however,* That such tools or other materials may be placed without lashing in a closed box or in a mine car when lowered in a cage, or in a skip, or in a special tool bucket, when no tool projects above the edge thereof.

HOISTING WHILE SINKING SHAFT.

Rule 11.—In no case shall a cage, skip, or bucket or other vehicle be lowered directly to the bottom of the shaft when men are working there, but such cage, skip, or bucket or other vehicle shall be stopped at least 15 feet above the bottom of such shaft until the signal to lower farther shall have been given to the hoisting engineer by one of the men at the bottom of the shaft: *Provided, however,* that this rule shall not apply to shafts of less than 100 feet in depth.

DEEPENING SHAFT—PROTECTION.

Rule 12.—During shaft-sinking operations no other work in any other place in the shaft shall be executed, nor shall any material or tools be hoisted or lowered from or to any other place in the shaft while men are at work in the bottom of the shaft unless the men so at work be protected from the danger of falling material by a securely constructed covering extending over the whole area of the shaft, sufficient closable openings being left in the covering for the passage of men and the bucket or other conveyance used in the sinking operations.

WHIMS.

Rule 13.—Whims in use at or in mines shall be provided with a suitable stopper or some other reliable device to prevent running back of the bucket or other conveyance.

CROSSHEADS.

Rule 14.—All vertical shafts more than 300 feet deep from which hoisting is done by means of a bucket shall be provided with suitable guides, and in connection with the bucket there shall be a crosshead traveling upon these guides. The height of the crosshead shall be at least two-thirds of its width.

The matter of crossheads is vexing. Although they are in rather general use, it is maintained in some districts that loose crossheads, which can become stuck in the shaft and afterwards dislodged so as to descend with dangerous force on the bucket, cause more accidents than they prevent. If loose crossheads be prohibited, sinking operations will necessitate that the bucket be suspended far below the crosshead, which is inconvenient for dumping, or that a rather elaborate device be employed, which is usually fast to the hoisting rope, but will permit the bucket to descend alone when the mechanism is tripped by a stop on the guides. In the face of these considerations, the committee has followed what seems the most generally accepted practice and has prescribed a crosshead of proportions to minimize the danger of catching on the guides without specifying whether it be loose or fast.

SIGNALS.

Rule 15.—Every shaft, if exceeding 50 feet in depth, shall be provided with an efficient means of interchanging distinct and definite signals between the top of the shaft and the lowest level and the various intermediate levels from which hoisting is being done. The signaling apparatus shall be a cord or wire actuating a knocker, bell, or whistle, which shall be supplemented by a speaking tube, or telephone, or an electrical system.

Rule 16.—Special care shall be taken to keep the signaling apparatus in good order, and all proper precautions shall be taken to prevent electric signal and telephone wires from coming into contact with other electric conductors, whether insulated or not.

PUNISHMENT FOR INTERFERENCE WITH SIGNALS.

Rule 17.—It shall be unlawful for any person to interfere with or impede any signaling in any mine, or knowingly to damage any signal system or knowingly to give or cause to be given any wrong signal within the mine or to ride upon any cage, skip, bucket, or other conveyance at a time when signals have been given informing the hoisting engineer that no person is so riding.

SIGNAL CODES.

Rule 18.—The following signals shall be used: One bell, hoist (when engine is at rest); one bell, stop (when engine is in motion); two bells, lower; three bells, men on cage about to ascend or descend; four bells (when shaft sinking is in progress), blasting signal; nine bells, or flashing of electric lights nine times in quick succession, danger signal, all men to get out of the mine.

Some discussion of the question of signaling appears in Chapter V.

Rule 19.—Special signals in addition to the above may be used in any mine, provided they are easily distinguishable by their sound or otherwise from the foregoing code, and do not interfere with it in any way.

Rule 20.—An easily legible copy of the above code, and of any special code adopted in any mine, shall be printed in letters at least one-half an inch high, on a board or metal plate not less than 18 by 18 inches, and shall be securely posted in the engine room, at the collar of the shaft and at each level or station. The superintendent of the mine shall be responsible for the carrying out of this rule.

CLEANING OF MANWAYS.

Rule 21.—The timbers in all manways in daily use shall be cleaned of all loose rock lodged upon them at least once in every 24 hours. Manways in daily use shall be kept clear of obstructions.

FIRE PROTECTION.

Rule 22.—In all heavily timbered stopes it shall be the duty of the mine foreman to cause fire inspection to be made after each shift shall have left such stope. A fire map shall be maintained showing all air and water lines in the mine and their dimensions with the positions of all valves and hydrants; and such map shall be brought up to date at least every six months.

TIMBERING.

Rule 23.—Every shaft, incline, slope, adit, tunnel, level, or drift, and any working place in the mine shall be, when necessary, kept securely timbered or protected to prevent injury to any person from falling material. It shall be the duty of the operator to carry out and enforce the provisions of this rule, but nothing contained herein shall be construed to relieve the miner from the duty of caring for his own working place, save as hereinafter provided.

Rule 24.—It shall be the duty of the operator to see that all miners in the mine are supplied at all times with such timbers as are necessary to keep their working places in a safe condition. For the purposes of this and the succeeding rules the term "timbers" shall be held to include and mean all wood to be used by the miner, or all steel or concrete material used in lieu of timber.

Rule 25.—If for any cause necessary timbers can not be supplied to any miner when required, it shall be the duty of the mine foreman to instruct the miner or miners to vacate all such working places until supplied with the timbers needed, but nothing contained herein shall be construed to relieve the operator of the duty of supplying such timbers.

FENCING DISUSED WORKINGS.

Rule 26.—All abandoned shafts, shafts temporarily out of use, or shafts used only as airways, shall be securely covered or fenced, and shall be so maintained. All mill holes, glory holes, and cavernous stopes opening to the surface shall be securely fenced, and shall be so maintained if such mill holes, glory holes, or

cavernous stopes are within 300 feet of a highway or thoroughfare. All other abandoned excavations whereof the sides slope more than 40 degrees from the horizontal, and whereof the depth is more than 10 feet, shall be securely fenced, but such fencing need be erected only at those places where such slope is in excess of 40 degrees, and all such fencing shall be maintained in good condition.

PENALTY FOR DESTROYING FENCES AND COVERINGS.

Rule 27.—Any willful removal of, injury to, or destruction in whole or in part of, any coverings or fences provided for in rule 26 of this section shall constitute a misdemeanor, and shall be punished as provided in section 52 of this act.

LIGHTING.

Rule 28.—Stationary lights shall be provided during the working hours at all shaft stations during the time the same are in actual use, and also at all stations on the levels where hoisting or hauling is effected by means of machinery, and also at night at all places on the surface where work is being conducted, and at the head of any shafts not fenced or covered.

Rule 29.—All places where hoisting, pumping, or other machinery is erected and in the proximity of which persons employed in the mines are working or moving about shall be so lighted that the moving parts of such machinery can be clearly distinguished.

PLACES OF REFUGE.

Rule 30.—In every mine in which mechanical haulage is employed there shall be at intervals of not more than 300 feet on each main haulage way, except in shafts, places of refuge affording a space of at least 2½ feet in width between the widest portion of the car or train running on the tramway and the side of the gallery. When electric-trolley haulage is used or when there is a lighting circuit in the haulageway, such places of refuge shall be marked by lights of a distinctive color, so placed as to be plainly visible from a distance of at least 50 feet in each direction in the haulageway.

Rule 31.—Every such place of refuge shall be kept constantly clear, and no refuse shall be placed therein, and no person shall in any way prevent access thereto.

PROTECTION AGAINST WATER.

Rule 32.—No raise shall be allowed to approach within 10 feet of any part of a winze, stope, or other opening in which there is a dangerous accumulation of water unless such winze or stope be first unwatered by bailing or pumping or by means of a bore from the raise.

Rule 33.—When advancing a drift, adit level, or incline toward a mine working that is suspected to be filled with water a bore hole shall be kept at least 20 feet in advance of the breast of the drive when in the vicinity of such mine working, and also, if necessary, in directions laterally from the course of the drive. Such a working place shall not exceed 6 feet in width, and such additional precautionary measures shall be taken as may be deemed necessary to obviate the danger of a sudden breaking through of water.

It is necessary that rule 33 should be somewhat indefinite in its requirements. On the one hand, no good object is obtained by requiring the bore hole to be kept 20 feet in advance of the breast of the drive during the entire distance that an adit level, tunnel, etc., is advanced toward a mine working suspected to be filled with water. On the other hand, it is hardly possible to fix a given distance within

which the bore must be kept in advance, as the workmen could not know exactly when they came within such distance.

Rule 34.—In every mine where, in the opinion of the inspector of mines, there is danger of a sudden inburst of water, such additional raises, drifts, or other workings shall be constructed as are necessary, in the opinion of the inspector, to insure the escape of workmen from the lower workings.

LADDERS AND LADDERWAYS.

Rule 35.—The distance between the centers of the rungs of a ladder shall not exceed 12 inches, and shall not vary more than one-half inch in any one ladderway.

Rule 36.—The rungs of a ladder shall in no case be less than 4 inches from the wall of the shaft or any opening in which the ladder shall be used.

Rule 37.—Every ladderway with an inclination of more than 45° from the horizontal, the vertical distance between the top and bottom of which is more than 100 feet, that may be used for the ascent and descent of persons working in the mine, shall have substantial platforms at intervals of not more than 20 feet measured vertically, and the inclination of any ladder or section of a ladder shall not exceed 80° from the horizontal.

In the discussion of the committee's preliminary draft some uncertainty or confusion of ideas seemed to exist as to the requirements of the proposed act with reference to ladders and ladderways, judging from some of the criticisms that have been made of the former draft. For this reason it seems desirable to group all such provisions in the form of a note, as follows:

1. Ladders may be fixed vertically in shafts or ladderways not exceeding 100 feet in depth, but may not be so fixed in shafts over that depth. (Rule 40.)

2. Ladderways more than 100 feet deep must have platforms at intervals of 20 feet. The inclination of ladders shall not exceed 80 degrees from the horizontal. (Rule 37.)

3. Shafts that are more than 200 feet deep, and where a single shaft affords the only means of ingress and egress, and where only one outlet is required, must be divided into compartments, one of which compartments shall be used exclusively as a ladderway. (Sec. 41.) Under rule 37, this ladderway would have to be provided with platforms at intervals of 20 feet.

4. All mines must provide at least one means of outlet for the miners by means of ladders from the lowest workings to the surface. If less than 100 feet in depth, rule 40 would apply; if more than 100 feet in depth, rule 37 would apply; and if more than 200 feet in depth, section 41 would apply, provided a single shaft afforded the only means of ingress and egress.

Rule 38.—All such platforms, except for an opening large enough to permit the passage of a man, shall be closely covered.

Rule 39.—Ladders shall project at least 3 feet above every platform in the ladderway and at least 3 feet above the collar of the shaft, unless handrails shall be fixed at such places.

Rule 40.—In vertical workings not exceeding 100 feet in depth or height ladders may be fixed vertically; no vertical ladders shall be used with a greater height or depth than 100 feet. *Provided however*, That around every such vertical ladder, sollars or platforms shall be built which shall be not more than 20 feet apart and shall be constructed as provided by rule 38 of this section.

Vertical ladders of any height such that a fall therefrom would result in serious injury are undesirable underground. The committee would like to prohibit their use altogether. Records of fatal falls from vertical ladders are common and records of cases where the fact that ladders were inclined and interrupted with sollars prevented falls from being fatal are almost as common. Furthermore, vertical ladders are rarely necessary, and whereas the introduction of inclined ladders with sollars has often encountered prejudice at first, it is found that their use over even a short period of time has always brought them into favor. Nevertheless the committee recognizes that such a prejudice does exist in some quarters and that to change over all installed vertical ladders would work a hardship on many mines. For this reason they have not been prohibited entirely, but it is urged that all ladders hereafter installed be inclined and interrupted with sollars at least every 20 feet.

Rule 41.—Under no circumstances shall any ladder inclining backward from the vertical be installed.

The danger resulting from the use of a ladder inclining backward is well known. Rule 41 provides that no such ladder shall be installed. The last word is used advisedly, the committee recognizing the difficulty of preventing ladders in stopes from being thrust out of position by the movement of the timbering in the stope. The obligation to correct all of such displaced ladders might be unnecessarily onerous. A careful superintendent will see, however, that proper correction is made in ladderways that are much used.

Rule 42.—Ladderways shall be provided in all shafts in the course of sinking to within such a distance from the bottom thereof as will secure them from damage by blasting. From the end of such ladderways, chain, wire rope, or wooden extension ladders to reach to the bottom of the shaft shall be provided.

Numerous instances of men being trapped in the bottom of a shaft after the fuses of a round of shots have been lighted and the hoisting engine has failed to work emphasize the necessity of a strict observance of rule 42. See also rule 13 of section 33 and the remarks thereon. Men may be trapped also by other accidents, for example, fire and inrush of water.

ENFORCEMENT OF RULES 35 TO 42.

Rule 43.—It shall be the duty of the superintendent to enforce the carrying out of rules 35 to 42.

SUMPS.

Rule 44.—All sumps shall be securely covered except when being cleaned or repaired or for similar purposes.

STOPES.

Rule 45.—In stopes timbered with square sets the working floors shall be closely and securely lagged over. Lagging shall be long enough to reach entirely across the caps or girts; or shall reach to the center of the cap or girt at each end and shall be spiked. Openings in the floors shall be protected by railings.

WINZES OR RAISES.

Rule 46.—Winzes opening directly from the floor of a drift or stope shall be kept covered by a substantial hatch, or shall be planked over, except when in use, or shall be barred off by a substantial railing not less than $3\frac{1}{2}$ feet nor more than 4 feet above the level of the floor, or shall be provided with a gangway not less than 10 inches wide, which gangway shall have a substantial handrailing not less than $3\frac{1}{2}$ feet nor more than 4 feet above the gangway, and the approaches to such gangway at either end shall be protected by a substantial railing not less than $3\frac{1}{2}$ feet nor more than 4 feet above the floor.

An offset winze protected by a railing is the safest arrangement, but is not always practicable.

Rule 47.—Stopes opening directly from the floor of a drift shall be protected by a fence or a substantial handrail not less than $3\frac{1}{2}$ feet nor more than 4 feet in height above the floor of the drift, or such stopes shall be securely planked over.

Rule 48.—Drifts used as manways intersecting overhead workings through which material is dropped shall be closed to the passage of persons by a substantial rail not less than $3\frac{1}{2}$ feet nor more than 4 feet in height above the level of the drift, on each side of the working, whenever material is to be dropped through such working, and the drift shall be kept so closed during periods when the working is so in use.

SHAFT PROTECTION.

Rule 49.—At all shaft stations a gate or a guardrail not less than $3\frac{1}{2}$ feet or more than 4 feet above the floor shall be provided and kept in place across the shaft, except when the cage, skip, bucket, or other conveyance is being loaded or unloaded thereat, but this prohibition shall not forbid the temporary removal of the gate or rail for the purpose of repairs or other operations if proper precaution to prevent danger to persons be taken.

The committee considered prescribing a tight fence for the shaft stations similar to that prescribed for the shaft collar in rule 50 following. The use of such fences, however, is not common practice and the committee did not care to require them in the body of the law, although recommending them as a wise safety provision.

Rule 50.—The top of all shafts shall be protected by a tight fence, which may be provided with the necessary gates to give access to the shaft, but such gates shall be kept closed when access to the shaft is not necessary.

Rule 51.—If hoisting be done from greater depth than 100 feet by means of a bucket, shaft doors shall be constructed that will prevent any material from falling into the shaft while the bucket is being dumped, and such doors shall be closed while the bucket is being dumped.

Rule 52.—All stations or levels shall have such a passageway through or around the working shaft that crossing through the hoisting compartment may be avoided; entering or crossing the hoisting compartment of a shaft except to ascend or descend, or for the purpose of effecting repairs is prohibited; before repairs are commenced the person in charge of or directing the repairs shall inform the hoisting engineer of the nature thereof.

OILING CAGE SAFETY CATCHES.

Rule 53.—The safety catches of cages shall be kept well oiled and in good working order, and shall be tested at least once a month. Such test shall consist of releasing the cage suddenly in some suitable manner so that the safety catches shall have opportunity to grip the guides.

EXPLOSIVES.

Rule 54.—Every mine thawing dynamite or other explosives containing nitroglycerin shall be provided with a separate place for that purpose on the surface, or with a special underground chamber, which shall be a separate drift or crosscut, and it shall be unlawful to thaw explosives in any other place or in any other manner than as provided by rules 55 to 57 of this section.

In some mining districts, especially in cold climates, a central thawing house is impracticable, inasmuch as the mine workings may be at such great distances apart, and without underground communication, that the explosive may freeze solid before it can be carried to the working places. Under such conditions the absolute prevention of storage of explosives in the mine might be more dangerous than such storage, although in general the underground storage of explosives is deprecated and ought not to be permitted if storage elsewhere be practicable.

Rule 55.—Dynamite or other explosives containing nitroglycerin shall not be thawed by any means other than a steam bath or a hot-water device, or by manure, or by electric current. If steam or water be the agent employed, the stove, boiler, or other primary source of heat shall not be nearer to the thawing room than 10 feet. If electric current be the heating agent, the current shall not be brought within 10 feet of the explosives to be thawed.

Direct electric heating for the thawing of explosives is dangerous, and in the opinion of the committee should not be permitted under any circumstances. Indirect electric heating carried out in such a way that the heater is put in an antechamber to the thawing room or place, the heating of the thawing room being effected by the circulation of warm fluid from the antechamber, is considered safe and allowable.

Rule 56.—It shall be unlawful to thaw dynamite, or other explosive containing nitroglycerin, by placing it near a fire or near a steam boiler.

Rule 57.—It shall be unlawful to thaw dynamite, or other explosive containing nitroglycerin, by direct contact with steam.

Rule 58.—It shall be unlawful for any person knowingly to distribute frozen dynamite, or other explosive containing nitroglycerin, to any person working

in any mine, unless such explosive is to be thawed in accordance with rules 55 to 57 of this section.

Rule 59.—It shall be unlawful to carry explosives on an electric locomotive, or in a car next to an electric locomotive, or on a gasoline locomotive or in any car hauled by a gasoline locomotive.

Rule 60.—It shall be unlawful to place or leave explosives near live electric wires.

Rule 61.—No person shall remove any explosive from a mine without the written consent of the superintendent of the mine.

FUSES.

Rule 62.—No fuse shall be used in any mine that burns faster than 3 feet in 80 seconds or slower than 3 feet in 130 seconds. From every case of fuse opened, or from every lot of 6,000 feet, two coils shall be selected at random and pieces cut from such two coils shall be tested for rate of burning.

Rule 63.—Notice shall be posted at the entrance of every mine stating the rate of burning of the fuse used in such mine. The superintendent shall be responsible for the carrying out of this rule.

REPORT OF PERSONAL ACCIDENTS.

Rule 64.—Every personal accident occurring in or about any mine, including electric shocks and burns, and all accidents in connection with the operation of electrical equipment shall be promptly reported to the mine superintendent by the person injured, or, if such person shall be unable so to do by reason of the injury, then it shall be so reported by the person in immediate charge of the work at the time of the accident, or by some person acting in behalf of the injured person; and shall be recorded in a book kept for that purpose in the office of the mine, which book shall at all times be open to examination by the inspector or any deputy.

GENERAL RULES.

Rule 65.—All defects in or damage or injury to machinery or timbering or to apparatus and equipment generally in and about a mine, all unsafe or dangerous conditions in any part of the mine, and all accidents occurring in the course of mining operations, other than those of a purely minor character, even though not resulting in personal injury, shall be promptly reported to the mine foreman or superintendent by the person observing the same.

Rule 66.—Wages shall not be paid on any premises used for the sale of intoxicating liquors.

Rule 67.—Strangers or visitors shall not be allowed underground in any mine unless accompanied by the operator or an official of the mine, or by an employee deputized by such operator or official to accompany them; but this rule shall not apply to engineers sampling or inspecting the mine or to students of mining schools who are making a study of operating conditions in such mine, or to the mine inspector or deputy inspectors.

Rule 68.—Every mine employing more than 25 men shall maintain a suitably equipped wash room, which shall at all times be open to the employees of the mine.

Rule 69.—Each workman employed in the mine when first engaged shall have his attention directed by the mine foreman to the general and special rules provided for in this act.

SECTION 50.

ELECTRICAL INSTALLATION.

GENERAL.

Rule. Subject.

1. GROUNDING.
2. VOLTAGE.
3. GROUND DETECTORS.
4. SWITCHBOARDS.
5. DANGER SIGNALS.
6. PRECAUTIONS AGAINST SHOCK.
7. FIRE BUCKETS.
8. EMERGENCY LIGHTS.
9. PLAN OF ELECTRIC SYSTEM.
10. REPORT OF DEFECTIVE SYSTEM.
11. NOTICE OF INSTALLATION.

UNDERGROUND STATIONS AND TRANSFORMER ROOMS.

- 12-16. SWITCHBOARDS.
17. PROTECTION OF TERMINALS.
18. TRANSFORMER ROOMS.
19. PROTECTION OF CIRCUITS ENTERING OR LEAVING TRANSFORMERS.

TRANSMISSION LINES AND CABLES.

20. HIGH VOLTAGE WIRES.
- 21-22. SUPPORT OF CABLES AND WIRES.
23. OVERHEAD LINES ABOVE GROUND.
24. CABLES BURIED ON SURFACE.
- 25-26. PROTECTION OF CIRCUITS LEADING UNDERGROUND.
27. BRANCH CIRCUITS.
28. GROUNDED CIRCUITS.
- 29-30. LIGHTING CIRCUITS.
31. UNDERGROUND TROLLEY.
32. PROTECTION OF TROLLEY WIRES.
33. LOCATION OF WIRES.
34. POWER WIRES AND CABLES IN SHAFTS.
35. CABLES IN MAIN ROADS.
36. PROTECTION OF CABLES DURING BLASTING.
- 37-38. CABLES ENTERING FITTINGS.
39. JOINTS IN CONDUCTORS.
40. JOINTS IN CABLES.
- 41-46. FUSES, CIRCUIT BREAKERS, AND SWITCHES.

STATIONARY MOTORS.

47. PROTECTION OF STATIONARY MOTORS UNDERGROUND.

ELECTRIC LIGHTING.

48. LAMP SOCKETS.
49. FLEXIBLE LAMP CORD.
50. INCANDESCENT LAMPS.
51. SEPARATE CIRCUITS FOR HOISTS.

The following rules shall govern electrical installation and practices in every mine.

DEFINITIONS.

Potential.—The terms “potential” and “voltage” are synonymous and mean electrical pressure.

Difference of potential.—The expression “difference of potential” means the difference of electrical pressure existing between any two points of an electrical system or between any point of such a system and the earth as determined by a voltmeter.

Potential of a circuit.—The potential or voltage of a circuit, machine, or any piece of electrical apparatus is the potential normally existing between the conductors of such circuit or the terminals of such machine or apparatus.

Where the conditions of the supply of electricity are such that the difference in potential between any two points of the circuit can not exceed 300 volts, the supply shall be deemed a low-voltage supply.

Where the conditions of the supply of electricity are such that the difference of potential between any two points in the circuit may at any time exceed 300 volts, but can not exceed 650 volts, the supply shall be deemed a medium-voltage supply.

Where the conditions of the supply of electricity are such that the difference of potential between any two points in the circuit may at any time exceed 650 volts, the supply shall be deemed a high-voltage supply.

Grounding.—Grounding any part of an electrical system shall consist in so connecting such part to the earth that there shall be no material difference of potential between such part and the earth.

Underground station.—The term “underground station” as used herein shall mean any place where electrical machinery is permanently installed in the mine.

Carrying capacity.—The term “carrying capacity” shall be taken to mean the carrying capacity of a given wire as prescribed for various insulated wires in the National Electric Code, published by the National Board of Fire Underwriters.

Before undertaking the drafting of this section, an examination and study was made of the laws of various foreign countries, particularly the laws of New South Wales and of England. Bulletin 23 of the Bureau of Standards, “Standardization of Electrical Practice in Mines,” and the report of the so-called Taylor committee of the American Mining Congress, recommending the adoption of a code of rules governing electrical practice in coal mines, were also carefully examined and largely utilized. The most noticeable thing about these various laws and drafts of laws is the marked similarity of many of their respective provisions, many of which are practically identical in wording. The code of rules suggested by the Taylor committee has been embodied in the new bituminous-mining law of Pennsylvania, with few, if any, changes.

Obviously, then, with such a marked unanimity of view as to the correct standard for electrical practices in mines, and with the adoption of the Taylor report by the great mining State of Pennsylvania, great steps forward have already been taken toward the establishment of uniformity in electrical practices in mines. The committee has endeavored to make these rules regarding electricity as clear and

direct and simple as possible, and for the sake of uniformity has adopted a good many of the rules contained in the Taylor report, where no good reason existed why the same language should not be followed, although it has by no means followed that report exclusively.

The definitions of low, medium, and high voltages contemplate the measurement of the voltage with a voltmeter. A voltmeter, however, does not indicate the peak value of an alternating-current wave. It has, therefore, been urged that the limits be made lower in the case of alternating currents. If the voltmeter indicated 300 volts when connected across an alternating-current line, the peak voltage would be actually about 425 volts. This is true, furthermore, only when the curve of electromotive force is a sine curve. As this condition rarely exists, it follows that even greater peaks may be expected in alternating-current circuits. If different values were to be used in the case of alternating currents, the standard voltages used for secondary distribution would have to be taken into consideration. These are 220 and 440 volts. The sine-wave maximum with 220 volts would be about 310 volts and with 440 volts would be about 620 volts. The first of these values is just below one of the limits set and the second just above another limit. But although for the same voltmeter readings alternating-current circuits will have a greater maximum voltage and therefore to that extent will be more dangerous than direct-current circuits, nevertheless, in almost every case where alternating-current circuit is used, the conductors will be insulated much more thoroughly, and therefore it seems unwise to introduce confusion into the regulations by making distinctions.

GROUNDING.

Rule 1.—The frames and bedplates of generators, transformers, and motors, other than low-voltage, portable motors, installed underground shall be efficiently grounded. All metallic coverings, armoring of cables, other than trailing cables, and the neutral wire of three-wire, continuous-current systems shall also be so grounded.

VOLTAGE.

Rule 2.—No higher voltage than medium voltage shall be used underground, except for transmission or for application to transformers or to other apparatus in which the whole of the high-voltage circuit is stationary.

GROUND DETECTORS.

Rule 3.—All circuits leaving the switchboard in underground stations, and all circuits leaving the switchboard upon the surface and leading underground, shall, if circuits are completely insulated from the earth, be equipped with earth or fault detectors properly installed. Such detectors shall be inspected daily by a competent person, who shall report promptly to the superintendent of the mine the occurrence of any ground.

SWITCHBOARDS.

Rule 4.—Main and distribution switch and fuse boards shall be made of incombustible, nonabsorbent insulating material, which shall be free from metallic veins. The board shall be mounted upon supporting frameworks of iron or steel and fixed in a dry place. If insulated conductors are used in the wiring of the board the insulation of such conductors shall be flame proof.

DANGER SIGNALS.

Rule 5.—All high-voltage machines, apparatus, and lines shall be marked by the use of the word "danger" at frequent intervals.

PRECAUTIONS AGAINST SHOCK.

Rule 6.—Gloves and mats (or shoes) of rubber or other insulating material shall be provided by the mine superintendent for use in making repairs or adjustments to the live parts of any electrical apparatus.

FIRE BUCKETS.

Rule 7.—Buckets filled with clean, dry sand shall be kept in all underground stations ready for immediate use in extinguishing fires. The minimum quantity of sand thus stored in any one station shall be 2 cubic feet.

EMERGENCY LIGHTS.

Rule 8.—Lamps or other proper lights shall be kept ready for use in all underground stations where a failure of electric light is likely to cause danger.

PLAN OF ELECTRIC SYSTEM.

Rule 9.—The operator of every mine where electrical equipment is installed underground shall make or cause to be made by a competent person a clear and accurate plan, on a scale of not less than 200 feet to the inch, to be kept at the mine, showing the position of all stationary electrical apparatus in connection with the mine, including fixed cables, conductors, lights, switches, and trolley lines. The capacity in horsepower of each motor and in kilowatts of each generator or transformer shall be shown on such plan and the nature of its duty. This plan shall be corrected and be brought up to date at intervals of not exceeding three months, and shall at all times be subject to examination by the inspector or deputy. On failure or refusal of the operator to make such plan within three months after receipt of written notice so to do by the inspector or deputy, or failure at least once in three months to make the necessary corrections to bring the plan up to date, then the inspector is hereby authorized to have such plan or corrections thereof made, at the expense of the operator, as provided by section 25 of this act.

REPORT OF DEFECTIVE SYSTEM.

Rule 10.—A report shall be promptly made to the mine superintendent or mine foreman of every breakdown of any part of the electrical equipment in the mine, or of damage or injury thereto, or of any overheating, or of the appearance of sparks or arcs outside of the inclosing casings, or when any part of the equipment not a part of the electrical circuit becomes alive. It shall be the duty of the person first observing such breakdown, injury, damage, sparking, arcking, or the fact that some part of the equipment, not so supposed to be, is alive, to make such report or to communicate such fact to the person in charge of the equipment in question, who shall thereupon make such report as prescribed.

NOTICE OF INSTALLATION.

Rule 11.—Whenever any electrical installation is originally introduced into any mine notice thereof in writing shall be sent to the State mine inspector within three months from the date of such installation. Notice shall also be sent of any existing installation within three months after the coming into effect of this act.

UNDERGROUND STATIONS AND TRANSFORMER ROOMS.

SWITCHBOARDS.

Rule 12.—All switches, circuit breakers, rheostats, fuses, and instruments used in connection with underground motor generators, rotary convertors, high-voltage motors, transformers, and low and medium voltage motors of more than 50-horsepower capacity shall be installed upon a switchboard constructed as provided in rule 4 of this section. Similar equipment for low and medium voltage motors of 50 horsepower and less may be separately installed if mounted upon insulating bases of slate or equivalent insulating material.

Rule 13. Passageways.—A passageway not less than 3 feet in width shall be maintained in front of all switchboards installed underground, and any passageway behind the switchboard shall be of like width where there are connections at the back of such board. *Provided, however,* That in the case of high-voltage boards such passageways shall be not less than 4 feet in width.

Rule 14. Space back of switchboards.—The space at the back of switchboards shall be floored, shall be accessible from each end, and shall be kept locked up in the case of high-voltage boards, but no lock shall be used that will not permit the door being opened from the inside without the use of a key. Non-combustible flooring only shall be used at the back of high-voltage boards, except that rubber mats may be used as provided in rule 6.

Rule 15. Conductors crossing passageway.—No conductor shall cross a passageway at the back of a switchboard except below the floor, or at a height of not less than 7 feet above the level of the floor.

Rule 16. Live metal work on switchboards.—No live metal work shall be placed on the front of high-voltage switchboards within 7 feet of the floor. If live metal work is placed on the front of medium-voltage boards, insulating mats or floors shall be provided.

PROTECTION OF TERMINALS.

Rule 17.—All exposed terminals on underground machines shall be protected with properly designed insulating covers of suitable material, or with metal covers connected to earth.

TRANSFORMER ROOMS.

Rule 18.—Transformer rooms shall be of fireproof construction.

CIRCUITS ENTERING OR LEAVING TRANSFORMERS.

Rule 19.—Circuits entering or leaving a transformer shall be protected by a switch and an automatic circuit breaker on each pole, but fuses may be substituted for the circuit breakers in the case of lighting circuits, and in the case of power circuits transmitting 25 kilowatts or less.

TRANSMISSION LINES AND CABLES.

HIGH-VOLTAGE WIRES.

Rule 20.—All high-voltage wires used underground shall be in the form of insulated lead-covered cables, which may be either armored or unarmored, but

the lead or armor shall be electrically continuous throughout, and shall be efficiently grounded.

SUPPORT OF CABLES AND WIRES.

Rule 21.—All underground cables and wires, unless provided with grounded metallic covering, shall be supported by efficient insulators. The conductors connecting lamps to the power supply shall in all cases be insulated.

Rule 22.—Cables and wires unprovided with metallic coverings shall not be fixed to walls or timbers by means of uninsulated fastenings.

OVERHEAD LINES ABOVE GROUND.

Rule 23.—Overhead transmission lines between the generating station or substation and the mine entrance shall be supported upon insulators which shall be adequate in quality, size, and design for the voltage transmitted. Where such line is more than 500 feet in length lightning arresters shall be installed in connection therewith at the generating station and at the entrance to the mine. Such line at the lowest point shall be maintained not less than 14 feet above the ground and above any scaffold, trestle, or embankment used as a road or traveling way, except at the point of entrance to the mine.

CABLES BURIED ON SURFACE.

Rule 24.—Buried cables shall be sufficiently protected.

PROTECTION OF CIRCUITS LEADING UNDERGROUND.

Rule 25.—Every completely insulated feeder circuit in excess of 25-kilowatt capacity leading underground where the supply does not exceed the limits of a medium-voltage supply shall be provided above ground with a switch on each pole and an automatic overload circuit breaker on at least one pole in the case of direct-current circuits and on at least two poles in the case of polyphase alternating-current circuits. In the case of ground-return direct-current circuits a switch and current breaker shall be installed in the ungrounded side of the circuit, but may be omitted from the return side. Fuses may be substituted for circuit breakers in circuits transmitting 25 kilowatts or less.

Rule 26.—Every high-voltage alternating-current feeder circuit leading underground shall be provided above ground with an oil break switch on each pole, and every such switch shall be equipped with an automatic overload trip.

BRANCH CIRCUITS.

Rule 27.—Every branch circuit other than a trolley circuit shall be provided with a switch of not less than 100-ampere capacity on each pole at the point where it leaves the main circuit.

GROUNDING CIRCUITS.

Rule 28.—The nongrounded side of grounded circuits shall be efficiently insulated from earth.

LIGHTING CIRCUITS.

Rule 29.—Where wires for electric lamps are connected to a trolley wire the ear of the trolley hanger to which connection is made shall be provided with a drilled lug and a set screw for attaching the lighting wire. Such lighting wires shall not be wrapped or tied about the seams or studs of trolley hangers.

Rule 30.—Wires for all lighting circuits shall be covered with an insulation adequate for the voltage of the circuit, and, unless encased in pipes or other metallic covering, shall be strung on porcelain or glass insulators. Separate

uncased wires shall be kept at least 3 inches apart, except where they enter the fittings. Metallic casings, if used, shall be efficiently grounded.

UNDERGROUND TROLLEY.

Rule 31.—Trolley wires shall be installed as far to one side of underground workings as is practicable, and shall be securely supported upon hangers efficiently insulated and placed at such intervals that the sag between points of support shall not exceed 3 inches.

PROTECTION OF TROLLEY WIRES.

Rule 32.—At all places where men are required to work or pass regularly under trolley or other bare power wires, which are placed less than 8½ feet above top of rail, a suitable protection shall be provided, which may consist of channeling the roof, or of placing boards along the wire, which shall extend 3 inches below it, or in the use of any other device that will afford protection. All such places shall be well lighted with electric lamps.

LOCATION OF WIRES.

Rule 33.—All wires, except telephone, shot-firing, and signal wires, shall be on the same side of the working as the trolley wire.

POWER WIRES AND CABLES IN SHAFTS.

Rule 34.—All power wires and cables in hoisting shafts or manway compartments shall be highly insulated and substantially fixed in position. All shaft cables shall be supported by grips that can not cause abrasion of the covering or insulation, so spaced that no part of the cable shall be under a tension greater than one-fourth its ultimate strength. Where the cables are not completely boxed in and protected from falling material, space shall be left between them and the side of the shaft so that they may yield and lessen a blow from falling material.

CABLES IN MAIN ROADS.

Rule 35.—Where the cables or feed wires in main roads can not be kept at least 12 inches from any part of the mine car or locomotive, they shall be specially protected by proper guards.

PROTECTION OF CABLES DURING BLASTING.

Rule 36.—Cables shall be temporarily protected against damage at any point where workings are being repaired or where blasting is being carried on.

CABLES ENTERING FITTINGS.

Rule 37.—The exposed ends of cables where they enter fittings of any description shall be so protected and finished off that moisture can not enter the cable, or the insulating material leak out, if of an oily or viscous nature.

Rule 38.—Where unarmored cables or wires pass through metal frames or into boxes or motor casings, the holes shall be substantially lined with insulating bushings.

JOINTS IN CONDUCTORS.

Rule 39.—All joints in conductors shall be mechanically and electrically efficient, and shall be soldered wherever possible. Where conductors can not be soldered together, suitable screw clamps or connectors shall be used. All joints in insulated wire shall, after the joint is complete, be reinsulated to the same extent as the remainder of the wire.

JOINTS IN CABLES.

Rule 40.—Where cables are joined, suitable junction boxes shall be used, or the joints shall be soldered, and the insulation, armoring, or lead covering replaced in as good condition as it was originally.

FUSES, CIRCUIT BREAKERS, AND SWITCHES.

Rule 41.—Fuses and automatic circuit breakers shall be constructed so as effectually to interrupt the current when a short circuit occurs or when the current through them exceeds a predetermined value. Open-type fuses shall not be used.

Circuit breakers shall be adjusted to trip at from 50 to 150 per cent of their normal rated capacity, and shall be provided with indicators that shall show at what current the circuit breakers are set to trip.

Rule 42.—Circuit breakers used to protect feeder circuits shall be set properly to protect the circuit, but shall always be set to trip before the current exceeds by more than 50 per cent the current-carrying capacity of the feeder.

Rule 43.—All points at which a circuit has to be made or broken shall be provided with proper switches, which shall be so installed that they can not be closed by gravity.

Rule 44.—Fuses shall be stamped or marked, or shall have a label attached, indicating the maximum current that they are intended to carry. Fuses shall be adjusted or replaced only by an authorized and competent person.

Rule 45.—The capacity of fuses used to protect feeders shall not exceed the current capacity of the feeder by more than 25 per cent.

Rule 46.—All switches, circuit breakers, and fuses shall have incombustible bases.

STATIONARY MOTORS.

PROTECTION.

Rule 47.—Stationary motors underground, together with the starting resistance, shall be protected by a fuse on each pole, or by a circuit-breaking device on at least one pole for direct current, and two poles for alternating current motors, and by switches arranged to cut off entirely the power from the motor. These devices shall be installed in a convenient position near the motor. Every stationary motor underground, of 100 brake horsepower or over, shall be provided with a suitable meter to indicate the load on the machine.

ELECTRIC LIGHTING.

LAMP SOCKETS.

Rule 48.—The exterior of the sockets of all fixed incandescent lamps shall be entirely nonmetallic.

FLEXIBLE LAMP CORD.

Rule 49.—The use of flexible lamp cord for lighting connections is prohibited, except for portable incandescent lights to be used in connection with the inspection and repair of machinery and equipment. Such portable lights shall be protected by a wire cage large enough to inclose both lamp and socket and shall be provided with a handle to which the light and socket shall be firmly attached and through which the leading-in wires shall be carried.

INCANDESCENT LAMPS.

Rule 50.—Incandescent lamps shall be so placed that they can not come into contact with combustible material; and shall be so placed that an adequate circulation of air may take place on all sides of them.

Without the precautions prescribed in rule 50 incandescent lamps have been known to cause disastrous fires.

SEPARATE CIRCUITS FOR HOISTS.

Rule 51.—Where electric hoisting is employed, at least one shaft accessible from all parts of the mine shall be equipped with an electric hoist supplied by separate feeders run from any convenient distributing point so that the power on either or both circuits can be kept on when all other circuits in the mine are cut. *Provided, however,* That any hoist driven otherwise than by electricity and actually in use shall be considered the equivalent of an electric hoist with such separate circuit for the equipment of such generally accessible shaft.

SECTION 51.

CARE OF ELECTRICAL EQUIPMENT, AND PRACTICES.

Rule 1.—It shall be unlawful for any person working in or about a mine to cause willfully another person to receive an electric shock.

Rule 2.—It shall be unlawful to direct or permit an inexperienced person to work on live apparatus.

Rule 3.—No person shall handle electric wires or conductors, or electrical apparatus of any kind, or enter an electrical machine room or underground station without authority.

Rule 4.—No person shall be allowed to work any electrically driven apparatus unless he shall have been previously instructed in the performance of his duties by a competent person and shall have been duly authorized by the mine superintendent or mine foreman.

Rule 5.—No repairing or cleaning of any electrical apparatus, except mere oiling or wiping, shall be done when the current is on.

Rule 6.—Electric lamps underground shall not be installed or replaced save by a competent person to be designated or appointed by the mine foreman.

Rule 7.—Instructions for the restoration of persons suffering from electric shock shall be posted at the entrance to the mine, in every generating station or substation, and in all underground stations. All employees working in connection with electrical apparatus shall be required by the mine superintendent to familiarize themselves with these instructions, and shall be capable of applying them before entering upon such work.

Rule 8.—It shall be unlawful to damage willfully or without proper authority to alter or make connections to any electrical lines or conductors, machines, apparatus, or part thereof, used in connection with the supply or use of electricity. Any violation of this provision shall be deemed to constitute a misdemeanor and shall be punished as hereinafter provided.

Rule 9.—All apparatus and wiring shall be inspected at least once in every 15 days by a person designated for the purpose by the superintendent. Such person shall make a report once in each month, to the superintendent, of the inspections he has made, noting all defects found and how repaired or remedied.

SECTION 52.

PENALTIES.

Any person who neglects, refuses, or fails to perform or discharge the duties or responsibilities imposed and required to be performed or discharged by any section, clause, provision, or rule of this act, or who does any act or thing declared to be unlawful or prohibited by any such section, clause, provision, or

rule, or who violates any provision or requirement of this act, shall be deemed guilty of a misdemeanor, and, upon conviction thereof in the circuit court of the county in which the misdemeanor was committed, shall be punished by a fine not exceeding \$500 or by imprisonment in the county jail for a period not exceeding six months, or by both such fine and imprisonment, at the discretion of the court, unless otherwise provided.

The circuit courts of all counties within this State shall have and exercise, within the limits of their respective districts, jurisdiction over all offenses and proceedings under this act. All fines and penalties imposed or payable under this act may be recovered by distress and sale of any mining or other personal property of the offender; and, in default of sufficient distress, by imprisonment for any term not exceeding six months.

It shall be the duty of all county prosecuting officers or attorneys to prosecute all violations of this act, or all cases of neglect, refusal, or failure to perform or discharge the duties or responsibilities imposed and required to be performed or discharged by said act, but nothing herein contained shall operate to prevent the inspectors of mines, or any deputy, from procuring the services of counsel in accordance with the provisions of section 6 of this act. It shall also be the duty of such prosecuting officers or attorneys, upon request duly made, to assist the inspector of mines or any deputy in obtaining compliance with this act, or any provision thereof, by the institution of appropriate legal proceedings, and to represent such inspector or deputy in any and all legal proceedings brought against him in his official capacity.

For any injury to person or property occasioned by any violation of this act or any neglect or failure to comply with its provisions on the part of any owner, operator, superintendent, mine foreman, or hoisting engineer of any mine, a right of action shall accrue to the party injured against said owner or operator for any direct damages sustained thereby; and in case of loss of life by reason of such neglect or failure aforesaid, a right of action shall accrue to the widow and lineal heirs of the person whose life shall be lost for like recovery of damages for the injury they shall have sustained.

The committee has endeavored to place the responsibility for certain conditions and the observance of certain requirements upon those who should clearly be responsible, the operator in some instances, and in others the superintendent or the mine foreman. It is recognized that many accidents are due to the miners themselves, owing to carelessness or recklessness or to willful disregard of safety rules, but it is not practicable to penalize the miners for all of such acts. Of course, the miner, as well as the operator or superintendent, is personally liable for the doing of an act expressly made unlawful, and the doing of which constitutes a misdemeanor. If a miner persistently violates safety requirements the operator can terminate his employment, if nothing more, or he may, if desired, report the violation of law to the local prosecuting officer or to the mine inspector. Although the men may not be reached in some instances, it is certainly true that a miner injured by reason of the doing of some prohibited thing—that is, violating the law—would have no recourse against the operator, which is in itself a penalty of a more or less drastic character.

SECTION 53.

COPY OF ACT TO BE POSTED.

It shall be the duty of the inspector of mines to furnish every mine with a copy or copies of said act, and it shall be the duty of the superintendent of every such mine to post or cause such printed copy or copies to be posted, and to be kept posted at all times in the office of said mine and on a building or board in some conspicuous place at each entrance to the mine.

The willful removal, injury, or defacing of any such printed copy when so posted by any person shall constitute a misdemeanor and shall be punished as provided in section 52 of this act.

SECTION 54.

REPEAL OF INCONSISTENT LAWS.

All laws or parts of laws inconsistent with the provisions of this act are hereby repealed.

SECTION 55.

WHEN ACT SHALL TAKE EFFECT.

This act shall take effect on the _____ day of _____, 19—.

The act should take effect at least 90 days after passage, so as to enable operators to prepare to meet the changed conditions.

The reader of the above draft will perceive that it is widely different from our draft of 1910. The legal theory upon which it is based has remained unchanged, but technical details have been extensively altered. Further study would no doubt lead us to make further modifications. However, we are of the opinion that if the metal mines of the United States be operated in conformity with the rules herein prescribed the accidents to men will be materially reduced.

WALTER RENTON INGALLS,
Chairman.

J. PARKE CHANNING.

JAMES DOUGLAS.

JAMES R. FINLAY.

JOHN HAYS HAMMOND.

CHAPTER IV. SYNOPSIS OF PROPOSED LAW.

By L. O. KELLOGG.

A synopsis of the proposed act presented in Chapter III is given herewith:

SECTION 1. DEFINITION OF TERMS.

Gives application of act; provides short title; makes singular and plural numbers interchangeable; defines "mine," "mineral," "operator," "superintendent," "mine foreman," "inspector," "deputy," "excavations," "workings," "number of men," "explosive," "person," "underground," "employee," and "men employed." Operation of law restricted to mines employing over 10 men; collieries, and oil, gas, salt, and sulphur wells excluded.

SECTION 2. OFFICE OF INSPECTOR OF MINES.

Inspector must be 30 years old, American citizen, State resident for at least 1 year previous to appointment, with 10 years' practical experience underground (1 year's service as a deputy counting for 2 years of such experience), and 5 years' experience as superintendent or foreman of mine in United States employing more than 50 men. Salary specified. Term of office, 4 years. Inspector appointed by governor of State.

SECTION 3. DEPUTY INSPECTOR OF MINES.

Inspector shall appoint certain number of deputies at certain salary. Subject to removal by inspector. Qualifications same as for inspector, except that deputy need be only 25 years of age, with 2 years' experience as superintendent or foreman of mine in United States employing 25 or more men.

SECTION 4. RESTRICTIONS UPON INSPECTORS.

Inspector or deputy shall not be connected with any mining, metallurgical or quarrying company. Must devote entire time to office; must not engage in practice as consulting engineer; must not act for political candidate or receive compensation therefrom.

SECTION 5. PAYMENT OF SALARY AND EXPENSES.

Provides for payment of salary and necessary expenses.

SECTION 6. LEGAL EXPENSES OF INSPECTORS.

Inspector may engage counsel to assist in legal proceedings under provisions of act, who shall be paid by State. If any suit result in costs against State, same shall be paid subject to approval by the court.

SECTION 7. OFFICE AND RECORDS OF INSPECTOR OF MINES.

Inspector to have office in statehouse; shall keep complete records of mine examinations and of recommendations with all data pertaining thereto; deputies to make periodical reports thereon to the inspector. All records property of State. Inspector may call for all papers of deputy when desired.

SECTION 8. REPORTS TO INSPECTOR OF MINES.

Every operator to make annual report to inspector, covering production, number of employees, days of work, number and nature of accidents, and information relative to safety of mine. If property changes hands between dates of reports, retiring operator shall furnish necessary information to his successor to enable latter to make out report. Any accident or threatened change of conditions which would increase hazard must be at once reported to inspector.

SECTION 9. DESIGNATION FOR SERVICE OF NOTICES.

Operator shall appoint a person on whom all legal notices can be served; he shall be in accessible situation; but any other responsible officer shall also be subject to such notices.

SECTION 10. SECRECY OF RECORDS.

Records of inspectors must be kept secret, except that information may be given to State government or in court, and findings regarding any mine to owner or superintendent thereof.

SECTION 11. DUTIES OF INSPECTORS—INSPECTION—POWERS.

Every mine employing more than 30 men shall be visited at least once every three months, and every other mine at least once a year, oftener if seems necessary to inspector; inspector shall examine operations as regards safety and ascertain whether provisions of act are observed; shall have access to any mine at any time and shall receive assistance of company officers; shall have authority to subpoena witnesses, take depositions, and take evidence after administering oath.

SECTION 12. DANGEROUS MINES—DUTIES OF INSPECTORS.

When inspector finds any unsafe condition he shall serve notice on operator, specifying necessary changes. If on reexamination conditions are not remedied, inspector shall procure temporary court injunction shutting down mine or part thereof until changes are made.

SECTION 13. REFUSING INSPECTION—PENALTY.

If inspector is refused permission to make inspection, he shall obtain court order requiring operator to permit inspection and furnish facilities, under penalty of being adjudged in contempt of court.

SECTION 14. RECORDS OF INSPECTION.

After each inspection of a mine, record shall be made thereof in a book kept at the mine, noting parts inspected, nature of inspection, defects observed; such book shall always be open to inspector or deputies.

SECTION 15. COMPLAINTS TO INSPECTORS.

If certain minimum numbers of men in mines of various sizes make signed complaint to inspector of any dangerous condition existing, inspector shall make immediate examination, and if he finds violation of act shall order a change. Names of men shall remain secret unless released by them.

SECTION 16. ACCIDENTS.

Notice of any serious accident shall be at once telephoned or telegraphed to inspector by company official. Inspector shall make immediate investigation and report thereon

within 20 days. If inspector or deputy can not proceed to mine, the person in charge of operations shall obtain sworn statements of witnesses and forward same to inspector.

SECTION 17. LOSS OF LIFE.

Fatal accident shall be reported as in section 16. Inspector or deputy shall endeavor to be present at coroner's inquest and shall have right to examine witnesses. Coroner may adjourn inquest certain number of days to await inspector. If inspector be not present and coroner discovers evidence showing culpability of mine operator, he shall notify inspector, who shall make immediate investigation. Coroner shall file with inspector a copy of evidence and verdict of jury.

SECTION 18. INSPECTOR TO FORWARD PAPERS TO PROSECUTING OFFICER IN CERTAIN CASES.

If inspector believes serious or fatal accident to have been caused by violation of act by company or employee, he shall forward papers applying thereto, with his statement showing manner of violation, to county prosecutor, who shall take steps for criminal prosecution, if he deems facts to make prima facie cause of action.

SECTION 19. STATISTICAL REPORTS OF MINE INSPECTOR.

Inspector shall make annual report to State government of the work of inspection, noting number of employees, number of accidents and nature, number of inspections, complaints made, inquests attended, mines ordered vacated, violations found, etc. Copies of report shall be printed and circulated as public document.

SECTION 20. REMOVAL OF INSPECTORS.

On receipt of petition signed by 100 miners or 10 operators or 3 operators employing over 100 men underground, setting forth neglect, incompetence, malfeasance, or unlawful act on part of deputy or inspector, county court shall summon accused official and make examination. If charges are proved, notice shall be sent to inspector or governor and official shall be removed. Costs shall be borne by inspector or deputy if removed, otherwise by complainants.

SECTION 21. SUPERINTENDENT TO BE APPOINTED.

Mine operator shall appoint superintendent, who shall be responsible for inspection of mine and for remedying all defects; the superintendent shall appoint man to have charge of powder magazines, and shall make other appointments as may be necessary.

SECTION 22. MINE FOREMAN TO BE APPOINTED.

Superintendent shall appoint foreman to have charge of underground workings, who shall be at least 21 years old, with at least two years' practical experience underground in metal mines, able to read and write English. Appointment must be made in writing, notice thereof posted at mine and sent to inspector. Failure to maintain foreman is misdemeanor. Foreman shall see that safety regulations are carried out, report and remedy violations of act, warn employees of danger, prohibit work in unsafe places except as absolutely necessary, and check number and identity of men going underground and coming off on every shift.

SECTION 23. CARE OF INJURED.

Every mine shall maintain stretcher, woolen blanket, and waterproof blanket; mines with more than 100 men shall maintain two of each. Every mine shall keep

on hand suitable quantity of first-aid materials, following list of the American Red Cross industrial first-aid box. Where 100 men are employed, a first-aid corps shall be organized and receive instruction at least once in three months.

SECTION 24. MINE MAPS.

Mine must maintain map of all underground workings and bring it up to date every six months. It shall be open at all times to examination by deputy or inspector, and if mine is closed down map or copy must be sent to inspector.

SECTION 25. FAILURE TO MAKE MAP—REMEDY.

If mine operator fails to make map after notification by inspector, latter can have map made at expense of his office and recover cost from operator.

SECTION 26. INFLAMMABLE MATERIAL.

Oils or other dangerously inflammable material shall not be stored within 100 feet of other building or of mine opening or within 300 feet of powder magazine; but volatile oils and fuel oils may be stored in vented, buried tanks within 50 feet of buildings or of mine openings and within 300 feet of magazine; and lubricating oils may be stored 30 feet from building or mine opening and 300 feet from magazine. Gravity flow to point of combustion not permitted unless accessible and rapid cut-off valve be installed. Not more than 24 hours' supply shall be taken at any one time from storage points. Possibility of flow by leakage within distances specified must be prevented. Not more than 24 hours' supply of illuminating oil to be stored underground. Not more than 6 gallons of any one kind of lubricating oil to be stored on any one level. No gasoline to be stored underground except that in tank connected to apparatus. No gasoline receptacle to be filled underground. Combustibles not to be stored within 50 feet of shaft station. Waste timber to be removed from mine unless buried in gob. Boxes, chips, paper, and other rubbish to be removed from mine every 24 hours. Inflammable structures, except wooden headframes, prohibited within 75 feet of shaft or hoist house. Inflammable material in building over mine opening to be removed and not stored within 30 feet of exterior wall. Waste used around underground machinery to be deposited in metal receptacles. Calcium carbide to be stored only on the surface and in dry, waterproof, ventilated buildings, in original metal packages not exceeding 100 pounds each; only one package in storage place to remain unsealed at one time, except for 1 pound or less in one other package.

SECTION 27. STORAGE OF EXPLOSIVES.

Term "magazine" defined. Not more than 48 hours' supply of explosives to be stored underground. Must not be kept underground where accidental discharge would cut off miners' escape; must be kept in stout boxes away from track, electric conductors or manways; scattering of particles prohibited. Black powder and high explosives not to be stored in same box. Not more than 75 pounds of explosive to be kept on any one level outside of magazine; such magazine shall be fireproof, kept locked, and in charge of one man. Explosives except detonators shall be stored on surface in magazine 300 feet from boiler house, engine house, habitation, mine opening, railway, or highway, except that inspector may grant exemption where situation makes this impossible. Magazine shall be waterproof, fireproof, bullet-proof, with protecting mounds of earth between it and buildings, etc.; character of floors specified; surrounding ground to be kept clean of inflammable material; electric wires inside to be in conduit and kept 10 feet from explosives; matches prohibited; screened ventilators prescribed; removal of explosives and washing of magazine prescribed

before alterations, which shall be conducted only with wood or soft-metal tools, all old material being burned and never nailed or screwed into. Detonators to be stored on surface in suitable magazine free from molestation; 48 hours' supply may be taken underground; not to be stored within 100 feet of other explosives underground or 300 feet above ground; not to be taken into magazine containing other explosive or transported therewith except as primer; all primers to be used within 10 hours; fuses to be capped only with crimpers at benches 50 feet from any storage place; not more than 1,000 detonators to be kept on any one level. Fuse not to be stored underground more than 72 hours. Oldest explosive shall be taken from magazine first; packages of explosives shall be opened only at safe distance from magazine and without metallic instruments.

SECTION 28. MARKING OF EXPLOSIVES, DETONATORS, AND FUSES.

Use of explosives, detonators, and fuse prohibited, unless every package be marked with name and place of manufacturer and date of manufacture and strength of contents.

SECTION 29. BLASTING.

Shot firers made responsible for blasting. Metal tamping rods and detonators of less strength than No. 6 prohibited. Approaches to blasting points to be protected by men or warning signs. Number of shots to be counted where possible and report made of possible misfires; in case of suspected misfire, no one shall return to blasting point for 30 minutes. Misfire shall be shot over when possible; if tight stemming be used, new hole shall be drilled at safe angle and exploded. After electric blast, no man shall return to work until shot firer disconnects blasting cable and examines working place; loose wires in muck to be reported and traced to source before work is continued. Electric firing from grounded circuit prohibited; blasting wires must not come into contact with other conductors; portable devices for electric firing to be in charge of shot firer; all connections for electric blast to be made last and by shot firer. Firing batteries to make all contacts in case, except binding post, which must be insulated at all points except point of contact; battery must have detachable plug or safety button for making contact, plug to remain in custody of shot firer. Light or power circuits not to be used for blasting unless connections are made in locked room in charge of shot firer.

SECTION 30. HOISTING ENGINEER.

Superintendent shall appoint hoisting engineers, who shall be familiar with the operation of hoisting engines and shall be over 21 years old if required to handle men, otherwise over 18. No one else shall operate a hoisting engine except in case of emergency and excepting apprentices.

SECTION 31. HOISTING.

Maximum rates of speeds to be used in hoisting men shall be established and posted, proportional to the depth of the shaft. Maximum number of men to be allowed to ride on shaft conveyance shall be determined and posted. Appointee of superintendent shall see that this number is not exceeded in hoisting or lowering. If mine has more than one level and employs more than 99 men underground, shaft conveyance shall be in charge of conductor who shall give all signals. If more than 99 men are employed underground there must be an extra man on platform with hoisting engineer when handling men at change of shift. Buckets with men thereon shall not be hoisted at more than 200 feet per minute when bucket is within 100 feet of the shaft collar or at more than 500 feet per minute anywhere.

SECTION 32. SAFEGUARDS AGAINST OVERWINDING.

Headframe shall be stronger than hoisting rope; shall be high enough to allow installation of safety chairs and Humble hook or equally good device for releasing rope in case of overwind. Such devices shall be installed, if mine employs more than 100 men underground; safety chairs shall be put in at distance below the releasing device 3 feet more than height of cage or other conveyance to its clevis, and shall be strong enough to stop the conveyance. If mine employs more than 100 men underground device must be put in shaft to show engineer when conveyance passes point 100 feet below collar, this device being independent of the usual indicator; but the rope release and warning signal may be omitted when an automatic stopping device is installed and kept in good order.

SECTION 33. DUTIES OF HOISTING ENGINEER.

Hoisting engineer shall keep watch over all machinery in his charge; shall not delegate his duties to anyone except apprentices or his relief; shall familiarize himself with and use the signal code herein provided; shall not run engine without brakes, indicators, and distance marks; shall allow nobody in engine room except those with business there or visitors authorized by the superintendent; shall not talk with anyone while engine is moving or signaling is going on; shall be especially cautious when handling men; shall not exceed posted hoisting speeds; shall inspect all apparatus under his charge and report defects; shall, after any stoppage exceeding one hour, run the shaft conveyance through the shaft at least once before handling men; shall do no hoisting in any compartment while repairs are going on there except to aid in making such repairs; shall land shaft conveyance at either top or bottom before turning over the engine to his relief; shall answer preliminary blasting signal by raising and dropping shaft conveyance; shall familiarize himself with and carry out requirements of rules 8, 9, 10, 11, 12, 18, and 19 of section 49 of this act.

SECTION 34. HOISTING ROPES.

Metal-wire ropes required for hoisting other than by human or animal power. Safety factor of six required for new ropes, based on manufacturers' tables and maximum dead hoisting load. Safety factor must never fall below 4.5. Ropes of standard construction shall be discarded when there are six broken wires in one rope-lay, when wires on crown are worn to 65 per cent of their original diameter, when there are more than three broken wires reduced by wear more than 30 per cent in cross section, when marked corrosion appears. Record of every rope must be kept, showing kind of rope, how, when, and where used, etc. After three years in service, even if idle, rope may not be used unless tested for ultimate strength. New fastening of rope to shaft vehicle must be made at fixed intervals. New rope and new fastening must be tested by trips before used for men. Ropes must be superficially inspected every day and, whenever a new fastening is made, the piece cut off must be examined with care. Rope must be securely fastened to drum or reel with one lap always left thereon. Either socket or thimble required for fastening to shaft conveyance. Rope must be protected with dressing. Shafts over 3,000 feet deep and shafts in which no compartment is used for handling men exempt from all the requirements of this section. Depth of inclined shaft shall be its vertical component.

SECTION 35. CAGES FOR HOISTING MEN.

Cage must be provided for vertical shafts over 300 feet deep except when sinking. Such cage shall have bonnet of two removable iron plates, sides of sheet metal or netting, gates or bars, handhold and safety catches.

SECTION 36. BOILER INSPECTION. COMPRESSED-AIR TANKS.

Boilers must be inspected every six months or oftener, and report thereof certified to inspector. Boilers shall have safety valves and steam and water gages, in accessible position, which shall be tested at least every six months and condition reported. Every receptacle storing compressed air above 40 pounds pressure with capacity over 6 cubic feet must be 50 per cent stronger than necessary to resist pressure permitted by safety valve; must be inspected like boiler; must be blown out every 24 hours; must not get hotter than 250° F.

SECTION 37. GUARD RAILS.

All machinery shall have its moving parts protected by coverings or rails; all stairs, trestles, dangerous walks, or platforms shall be provided with hand rails; but such protecting devices may be removed for repairs.

SECTION 38. WOMEN AND CHILDREN IN MINES—EMPLOYMENT PROHIBITED.

No woman, no girl, and no boy under 16 may work underground, but such may work in office or buildings; no boy may be employed without having presented affidavit that he is over 16.

SECTION 39. TWO OPENINGS TO SURFACE.

Every mine must have two openings to surface between which there must be a 50-foot space free of combustible material; there are exempt, however, (a) mines being connected to comply with provisions of this section, (b) prospecting and development properties, except that such if opened by timbered shaft shall not permit more than 50 men to work underground at once without providing shaft with sprinkling system, (c) mines in which one opening has been blocked but is being opened with diligence (subject to approval of inspector), (d) shaft mines less than 100 feet deep and extending less than 500 feet from shaft in any direction, (e) adit mines with opening less than 1,000 feet long, inclined shafts at flatter angle than 20° being considered adits.

SECTION 40. OPENINGS THROUGH OTHER MINES.

When two neighboring mines have established a communicating outlet, neither may close same without consent of the other and of the inspector; each shall inspect outlet every seven days and keep it clear of obstruction; if one operator does not keep his part of outlet in repair, the other shall have access thereto to repair same; each operator shall pay fair share toward upkeep of established outlet; if one desires to cease operations, other shall bear all subsequent expense; if one property suspend operations so as to render the other liable to danger from flood, the latter may close outlet.

SECTION 41. PROVISIONS AFFECTING MINES HAVING ONLY ONE OUTLET.

A shaft mine with only one opening shall have shaft divided in two compartments, one of which shall be a ladderway and free of shaft conveyances. If shaft is covered with nonfireproof building, manway must be bulkheaded at least 25 feet below collar and passageway driven to surface so as to come out at least 30 feet beyond wall of building, such passageway to have ladderway if necessary. Mine opened by adit shall have similar side outlet.

SECTION 42. PROTECTION OF OUTLETS AGAINST FIRE.

No mine opening shall be covered with a combustible structure except a headframe or a door. If an adit is covered by a building of any kind, it must be equipped with a door near the mouth which can be closed by a pull wire or cable from outside. In timbered mine with more than 100 men, every working from shaft used as manway must be equipped with metal or metal-covered door not more than 75 feet from shaft, capable of being made air-tight, for which purpose clay or earth must be at hand. Door must swing toward shaft and must be capable of being pushed open by man from inside.

SECTION 43. LADDERS AND LADDERWAYS.

Every mine must have at least one ladderway from lowest workings to surface. All manways steeper than 35° must be provided with ladderways or stairways. All outlets must be marked with signboards where more than one course is possible and by distinctively colored electric lights when a circuit is available.

SECTION 44. VENTILATION.

Adequate ventilation for men and animals must be supplied to every working place underground.

SECTION 45. SANITATION, DRY CLOSETS, DRINKING WATER, CHANGE HOUSES, ETC.

Dry closets, water-closets, or closet cars must be provided on every level in ratio of at least one for every 25 men; effectual cleansing and removal of contents at least once a day must be provided for; disinfectant or deodorizer must be provided for dry closet; only such closets shall be used by men underground; but men may go to surface, if desired. Animal barns underground must be cleaned every day. Good and sufficient drinking water must be provided on every level, protected from dust and against promiscuous drinking from same vessel. If more than 50 men are employed underground, there must be a well lighted and heated change house accessible at all hours. Damage to, misuse of, or failure to use any sanitary appliance is forbidden.

SECTION 46. ROOF INSPECTION.

Where mine is worked with chambers supported only by walls or pillars, competent man must be delegated to examine and clean roof; miner shall care for roof of his own working place; sides and roof of all traveling ways must be inspected and kept safe.

SECTION 47. SAFETY PILLARS.

No stoping shall be done within 20 feet of shaft used for hoisting until it is abandoned and inspector notified. Along boundary line a 10-foot pillar must be left, except by consent of owners on each side and of inspector, but no interference with extra-lateral rights is allowed.

SECTION 48. INTOXICATING LIQUORS PROHIBITED IN MINES.

No intoxicated person shall be allowed in mine or mine buildings, and no intoxicating liquors except for medicinal purposes.

SECTION 49. GENERAL RULES.

The following general rules shall be observed in every mine:

1. Operator and superintendent shall use every precaution to insure safety of workmen.
2. Assistant foremen may be appointed.

3. Superintendent shall not interfere with the carrying out of the foreman's duties.
4. Foreman shall see that dangerous places are fenced off and signs hung thereon.
5. Candles must not be left burning when men leave mine.
6. In timbered stations candles may be burned only in sconces.
7. Where more than 50 men are employed underground at least two fire-fighting helmets must be kept on hand. If these are self-contained, they shall not be used by untrained men.
8. A cager to be employed when hoisting by cage from two or more levels; he shall load and unload cage, give all signals, and he or conductor shall see that gates or bars of cages are properly closed.
9. No one shall ride on shaft conveyance with tools, timber, powder, or other material except to help handle them.
10. When ends of material project above top of shaft conveyance they must be securely fastened or put in receptacle.
11. Shaft conveyance must be stopped 15 feet above shaft bottom where men are working and lowered therefrom only on their signal.
12. Men sinking must be protected by covering.
13. Whims must be equipped with suitable device to prevent running back of bucket.
14. All vertical shafts over 300 feet must be equipped with guides when hoisting is done with bucket, and a crosshead provided with its height at least two-thirds its width.
15. Every shaft over 50 feet deep shall have pull-cord signaling system supplemented with speaking tube, telephone, or electric system.
16. Signal system must be kept in good order and electric signal or telephone wires out of contact with other conductors.
17. Interference with signaling, giving of wrong signal, or riding on conveyance without giving man signal is forbidden.
18. The signal code shall contain the signals: One bell to hoist; one to stop; two to lower; three, men on; four, about to blast; nine bells, general alarm.
19. Easily distinguishable and noninterfering special signals may also be used.
20. Legible code of signals with letters at least one-half inch high, on board or metal plate at least 18 by 18 inches shall be posted in engine room, at collar, and on each level.
21. Timbers in manways shall be cleaned of loose rock at least every 24 hours and manways shall be kept clear of obstructions.
22. All heavily timbered stopes shall be inspected for fire after every shift; fire map showing pipe line, valves, hydrants, etc., shall be maintained and brought up to date every six months.
23. Every working place shall be kept timbered as necessary to prevent injury from falling material.
24. Sufficient timber shall be supplied by operator, "timber" being taken here and elsewhere to include also steel and concrete.
25. If timber can not be had, foreman shall have miners vacate place where it is needed.
26. Shafts out of use or used only as airways shall be securely covered or fenced and maintained so; mill and glory holes and cavernous stopes opening to surface shall be securely fenced if within 300 feet of thoroughfare; all other surface excavations over 10 feet deep shall be securely fenced where the sides slope more than 40° from the horizontal.
27. Fences must not be willfully removed, injured, or destroyed.
28. Stationary lights must be maintained at shaft stations and stations containing hoisting or haulage machinery during working hours, and on surface at night where work is going on and at uncovered shafts.
29. All machinery must be so lighted that moving parts are visible to persons working near by.

30. Refuge places must be provided along all mechanical haulage ways, except shafts, giving $2\frac{1}{2}$ feet clearance over widest part of train and marked by lights when electric circuit is available.

31. Such refuges must not be obstructed.

32. Workings must be clear of water before raise can approach within 10 feet.

33. When horizontal working approaches working suspected to contain water, bore-holes must be kept 20 feet in advance and on sides if necessary; such working must not be more than 6 feet wide; if other precautions be necessary, they shall be taken.

34. When inspector judges that there is danger of outburst of water; he shall order constructed additional workings to facilitate escape of employees.

35. Ladder rungs shall not be over 12 inches apart and this distance shall not vary over $\frac{1}{2}$ inch in any one ladderway.

36. Rungs shall not be less than 4 inches from wall.

37. Ladderways steeper than 45° and extending more than 100 feet measured vertically must not have ladders steeper than 80° , and must have sollars every 20 feet measured vertically.

38. Sollars shall be closely covered, except hole to permit passage of man.

39. Tops of ladders shall extend 3 feet above landings, or handrails shall be fixed.

40. Vertical ladders permitted in vertical workings of less than 100 feet, but must have sollars every 20 feet.

41. Ladders inclining backward may not be installed.

42. Ladders must be provided to very bottom of all shafts in process of sinking.

43. Enforcement of rules 35 to 42 made incumbent on superintendent.

44. Sumps must be securely covered.

45. In square-set stopes floors must be securely lagged and openings fenced off.

46. Winzes directly in floor of stope or drift must be covered, or railed, or crossed with gangway railed and with railed approaches.

47. Stope opening in floor of drift must be railed off or covered.

48. Part of drift where material is being dropped from above must be railed off during such process.

49. Shafts must have rails or gates at stations.

50. Shaft collar must be protected by tight fence and gates.

51. When hoisting with bucket from more than 100 feet, shaft doors must be provided and kept closed while bucket is being dumped.

52. Must be passageway around shaft at every level. Crossing shaft is forbidden except to make repairs; notice must be given to hoisting engineer of such repairs.

53. Safety catches must be kept in good order and tested every month by releasing cage suddenly.

54. Explosives containing nitroglycerin must be thawed in separate and special place.

55. Thawing permitted by steam, hot water, manure, or electricity; with steam or hot water, primary source of heat must not be nearer than 10 feet to explosive and similarly with electricity.

56. Thawing by placing near fire or steam boiler prohibited.

57. Thawing by direct contact with steam prohibited.

58. Distribution of frozen explosive prohibited, except for thawing.

59. Explosives not to be carried on electric locomotive or in car next to one, or on gasoline locomotive or in car hauled by one.

60. Explosives not to be left near live electric wires.

61. Explosives not to be taken from mine without written consent of superintendent.

62. Fuse must burn between 3 feet per 80 seconds and 3 feet per 130 seconds, and every box must be tested.

63. Notice of rate of burning must be posted at entrance to every mine.

64. Personal accidents must be reported to superintendent and recorded.

65. Damage to anything underground and dangerous conditions must be reported by person first observing.

66. Wages may not be paid where liquor is sold.

67. Visitors not allowed underground unless accompanied by company officer or employee, excepting students, examining engineers, and inspectors.

68. Where more than 25 men are employed, wash room must be provided for employees and kept open to them at all times.

69. When engaged, every employee shall have attention called to rules of this act.

SECTION 50. ELECTRICAL INSTALLATION.

Definitions of "potential," "difference of potential," "grounding," "underground station," "carrying capacity." Low voltage is that under 300; medium, between 300 and 650; and high voltage, above 650. Gives the following rules for electrical practice in mines:

1. Frames and bedplates of underground machines (except low-voltage portable motors), metallic covering of fixed cables, and the neutral wire of three-wire continuous-current system must be grounded.

2. No higher voltage than medium to be used underground unless entire circuit be stationary.

3. All circuits leaving underground switchboard or surface switchboard and leading underground, if insulated from earth, must be equipped with earth detectors; daily inspection for grounding must be made.

4. Switchboards shall be of incombustible, nonabsorbent, insulating material, mounted on iron frame in dry place. Insulated conductors thereon must have flame-proof insulation.

5. All high-voltage apparatus to be marked with word "Danger."

6. Insulated gloves, mats, or shoes shall be provided for working on live apparatus.

7. At least 2 cubic feet of sand to be kept in buckets at each underground station for extinguishing fires.

8. Auxiliary lights to be kept in underground stations where failure of electric lighting circuit would cause danger.

9. Electrical underground map to be made, showing apparatus, conductors, lights, switches, and horsepower of apparatus; shall be brought up to date every three months. In case of failure to make map, inspector shall proceed as in case of mine maps.

10. Report shall be made to foreman or superintendent of injury to electrical apparatus or dangerous conditions.

11. Notice of original electrical installation must be sent to inspector.

12. Auxiliary instruments and apparatus for underground motor generators, for rotary converters, for high-voltage motors, for transformers, and for low and medium voltage motors over 50 horsepower shall be mounted as prescribed in Rule 4; for low and medium voltage motors of 50 horsepower and under, they may be mounted separately on insulating material equivalent to slate.

13. Passageways at least 3 feet wide shall be maintained in front of underground switchboards; and behind them, when there are connections there; for high-voltage boards, width shall be 4 feet.

14. Space back of switchboards shall be floored, accessible from both ends, locked in case of high-voltage boards, but capable of being opened from inside without key. Flooring back of high-voltage boards must be noncombustible, except for rubber mat.

15. No conductor shall cross passageway back of switchboard between floor and point 7 feet above.

16. No live metal work to be placed on front of high-voltage board within 7 feet of floor or on medium-voltage board unless insulating mat or floor be provided.

17. Exposed terminals on underground machines to be properly insulated or covered with grounded metal.

18. Transformer rooms to be of fireproof construction.

19. Circuits to or from transformers to be protected with switch or automatic circuit breaker on each pole or with fuse instead of circuit breaker on lighting circuits or power circuits under 25 kilowatts.

20. High-voltage underground wires to be in form of insulated, lead-covered cables, with lead or armor electrically continuous and grounded.

21. Underground circuits, unless covered with grounded metal, shall be supported on insulators; conductors from power supply to lamps to be always insulated.

22. Circuits without metallic covering not to be supported by uninsulated fastenings.

23. Surface transmission overhead lines to be supported on suitable insulators; if over 500 feet long to be equipped with lightning arresters at generating station and mine entrance; to be 14 feet above ground or place where men pass, except at mine entrance.

24. Surface-buried cables to be protected.

25. Every insulated circuit leading underground, of more than 25 kilowatts medium-voltage or under, shall have switch above ground on each pole and circuit breaker, on one pole of direct-current circuit, and on two poles of polyphase alternating current; switch may be omitted on grounded side of ground-return direct-current circuit; fuses may be used for circuit breakers for 25 kilowatts and less.

26. Such circuit, if high-voltage, shall have oil-break with switch automatic overload trip on each pole above ground.

27. Branch circuit, except trolley, to have 100-ampere switch on each pole where it branches.

28. Nongrounded side of grounded circuits to be efficiently insulated from earth.

29. Where wires for lights are connected to trolley wire, ear of hanger shall have drilled lug with set screw for attachment. Wires shall not be fastened around seams or studs of hangers.

30. Lighting circuits to have insulated covering; shall have metallic covering or be hung on insulators; separate uncased wires shall be kept 3 inches apart except where entering fittings; metallic casings shall be grounded.

31. Trolley wires shall be as far to one side as possible, shall be hung on insulated hangers so spaced that sag between supports does not exceed 3 inches.

32. Where men pass regularly below wires nearer rail than $8\frac{1}{2}$ feet, wires shall be protected for 3 inches below lowest point, and suitable lighting shall be provided.

33. All wires, except telephone, shot firing, and signal, to be on same side of working as signal wires.

34. Power circuit in hoisting shaft or manway to be well insulated and supported; shaft-cable grips must not cause abrasion, must be spaced so that no part of cable is stressed above one-fourth of its breaking strength; cables unboxed and unprotected must be spaced out from shaft side so as to yield to blow.

35. Cables or feed wires in main roads must be 12 inches from any part of train or protected by proper guards.

36. Cables to be protected against damage during repair work or blasting.

37. Entrance of cables to fittings to be protected against entrance of moisture or leakage of insulating material therefrom.

38. Unarmored cables or wires shall have entrances to metal frames, boxes, or motor casings, bushed with insulating material.

39. Conductor joints shall be mechanically and electrically efficient, soldered where possible, otherwise made with screw connections; joints in insulated wires to be reinsulated.

40. Cable joints to be made in junction boxes or by soldering; insulation, armoring, and lead covering to be brought to original efficiency.

41. Fuses and circuit breakers shall interrupt current when predetermined value is exceeded; open-type fuses not to be used; circuit breakers to be adjusted to trip at point between 50 per cent and 150 per cent of normal rated capacity, with indicators to show tripping point.

42. Circuit breakers on feeders shall be set to trip before current is in excess by 50 per cent.
43. Switches to be installed where circuit has to be made or broken shall not be capable of being closed by gravity.
44. Fuses to be marked indicating maximum capacity; to be manipulated only by competent person.
45. Fuse capacity on feeder shall not exceed feeder capacity by more than 25 per cent.
46. Fuses, circuit breakers, and switches to have incombustible bases.
47. Stationary underground motors and their starting resistances shall be equipped with fuse on each pole or circuit-breaking device on one pole for direct current and two poles for alternating and with switches to cut off all power from motor, devices to be in convenient position near motor; if over 100 horsepower motor must have suitable meter to indicate load.
48. Exterior of fixed incandescent lamp sockets to be entirely nonmetallic.
49. Flexible lamp cord prohibited except for portable lights used to inspect or repair machinery, when wire-cage protection for lamp and socket is required and handle for leading-in wires.
50. Incandescent lamps must not touch combustible material and must have circulation of air about them.
51. Where electric hoisting is employed there must be one hoist accessible from all parts of mine with separate feeder system or else some hoist actuated by means other than electricity.

SECTION 51. CARE OF ELECTRICAL EQUIPMENT AND PRACTICES.

Section 51 contains the following rules:

1. Causing a person to receive an electric shock is forbidden.
2. Inexperienced person not to work on live apparatus.
3. No person allowed around electrical apparatus without authority.
4. No person allowed to work on electrical apparatus without previous instruction and due authorization.
5. No repairing of electrical apparatus except oiling or wiping to be done when current is on.
6. Underground electrical lamps to be put in only by competent appointee.
7. Instructions for resuscitation of persons suffering from electric shock to be posted at mine entrance, generating station, substations, and underground stations. Electrical employees must be familiar with such instructions and capable of applying same.
8. Damage to electrical apparatus and alterations without proper authority prohibited.
9. Inspection of electrical apparatus to be made every 15 days by special appointee and report made to superintendent every month.

SECTION 52. PENALTIES.

Prescribing penalties for violations of act, jurisdiction of court, manner of recovery, duties of prosecuting officers, right of action for damages resulting from violation of act.

SECTION 53. COPY OF ACT TO BE POSTED.

Copy to be posted in office of mine and in conspicuous place near mine entrance.

SECTION 54. REPEAL OF INCONSISTENT LAWS.

Repeals conflicting laws.

SECTION 55. WHEN ACT SHALL TAKE EFFECT.

Prescribes date on which act becomes effective.

CHAPTER V.

DISCUSSION OF CERTAIN MATTERS OF PRACTICE.

By THE COMMITTEE.

At the end of Chapter II of this report the committee made the statement that the code here offered could not be considered the last word and that many problems had been found incapable of satisfactory solution. It is proposed in this chapter to take up the foremost of these problems and discuss them in some of their more important aspects for the double purpose of showing the difficulties encountered and of stimulating discussion and investigation in directions where they seem greatly needed.

STEAM-SHOVEL MINING.

In framing this code it was intended to cover not only underground mining but also operations in quarries and open pits, whether these last be mined with steam shovels or by other methods. The provisions of the code in their general scope do apply to such operations and many of the specific rules apply as well. The committee is aware, however, that there exist many hazards peculiar to steam-shovel mining against which no special provision has been made. The reason for this is to be found in the relatively recent development of this system of mining. Practice has not become uniform, methods are not yet standardized, and data are still too scanty to permit fair comparison of different methods of conducting operations, as regards safety. It seemed unwise to the committee to include in the code, rules and regulations of which the efficacy and practicability had not yet been sufficiently tried out and which might work hardships without resulting in any corresponding gain in safety. The committee felt the more ready to omit such specific regulations for the reason that steam-shovel mining seems to be safer than underground work. On this point definite statistics are lacking, but study of reports of inspectors would indicate a far lower death rate for open-pit work than for underground.

This is entirely what one would expect. The inherent danger would appear to be much less. The great hazard underground that results from lack of illumination is present in an open pit for less than half of the time. Another great hazard, that of material falling from overhead, is replaced by that of a sliding bank, which is much less grave. Entering and leaving an open pit involves some risk but less

than that of lowering and hoisting men in an underground mine. Blasting, although involving some peculiar risks in open-pit work, would seem on the whole much less likely to cause death or injury than when carried on in confined places underground. On the other hand, open-pit mining in general means a higher proportion of unskilled and consequently unintelligent labor than underground work.

Based on tonnage extracted, open-pit mining is, of course, still safer. The crews are relatively small and the tonnages produced per man are enormous.

ACCIDENTS IN OPEN-PIT MINING.

Accidents in open-pit mining with steam shovels may be classified as follows: Slides of bank; blasting accidents; accidents around the shovel or the drill; falls of persons; railroad accidents; miscellaneous accidents, including such accidents as acetylene or gasoline fires and explosions; accidents occurring in unloading cars; and shop accidents. Judging from available reports and from the rules which the mining companies set forth, blasting accidents and railroad accidents are the most frequent and the most to be guarded against.

SLIDES OF BANK.

Slides or falls of bank can not be considered comparable with falls of material underground as a source of injury. Except at night the bank is always clearly visible and threatening conditions are the more readily discerned. A slide of bank from its very nature gives some warning so that it may be possible to escape even after the slide starts. Nevertheless such slides have resulted disastrously, and since many operations in open-pit work are carried on by gangs of men which may be rather large, there is always the possibility that a single slide will catch a number of laborers. In Chapter XI will be found accounts of two such slides, each of which killed many men.

The avoidance of this danger would seem in general to consist of keeping the banks as flat as is economical and of watching them carefully. When anyone, such as a driller, is occupied under a bank from which the least danger is anticipated and is unable to keep watch on it, he should have some assistant do this for him.

It is also commonly prescribed by the companies operating steam-shovel properties that men shall work between the shovel and the bank as little as possible. The reason for this is obvious. In case of a rush of material, men between the bank and the shovel are liable to be crushed against the shovel side, whereas for those on the outside, the shovel acts as a bulwark. For night work as brilliant illumination as can be afforded ought to be employed.

Slides of large quantities of material are not the only danger from open-pit banks. Small quantities and single rocks may fall from a

high bank with sufficient force to kill or seriously injure anybody that they may strike. To meet this danger many companies employ men whose sole function is to trim the loose material off the banks of the pit.

BLASTING.

Open-pit blasting differs from underground blasting in many points. Black powder is used to a large extent and black powder, although not so powerful, is subject to explosion by fire and is more dangerous and treacherous on the whole than are the high explosives. Churn-drill holes or other holes are often chambered or sprung by a preliminary explosion at the bottom; this leaves the rock hot and if the final charge is inserted before the hole is cooled, a premature explosion is likely to result. In the wintertime it is difficult to keep explosives thawed and warm until they are exploded. On the other hand, there is little danger that men may be trapped, as in shaft sinking; operations are usually visible; there is less blasting done for the tonnage produced; warning can be given effectively by the shovel whistles; there is no danger of asphyxiation; electric firing with all precautions is entirely feasible; and the fact that the individual holes are usually large and few in number makes it practicable to take precautions which would be uneconomical underground.

Based on a study of the rules of practice at typical copper and iron steam-shovel mines, the following precautions in regard to blasting appear desirable:

Thawers of approved design and adequate capacity should be provided. The thawed powder should be conveyed to the hole to be blasted in insulated boxes during cold weather in order to prevent its freezing and should not be kept exposed even thus longer than necessary. There should be no greater accumulation of powder near the hole than is needed. The charge should be deposited at least 50 feet from the collar of the hole and brought to the hole only as fast as it is actually inserted. The underground precaution of keeping detonators and dynamite separate until the last possible moment must be amplified to the keeping of detonators, dynamite, and black powder all separate. None of these should be transported or stored with another. Covers of tarpaulin or other material should be provided near the hole to protect against dampness and sparks the supply of explosive being loaded. Since the holes are large and relatively few, all the blasting can be put in charge of careful and skilled men, trained to the work. No employees other than such blasting gangs should be allowed near the hole being charged. Hob-nail shoes and heel and toe plates should be prohibited for the blasting gang, inasmuch as they may strike fire.

No hole after springing should be loaded with its final charge until the rock is unquestionably cool; deluging it with water insures its being cool. The charging of black powder into the inclined or flat

"gopher holes" used in the Mesabi open pits should be conducted with great care and by some device which will prevent there being left a train of powder through the hole. The black-powder cans should be handled with extreme caution. Powder should be removed only through the bunghole, the cans should never be cut open for this purpose, and empty cans should not be rolled down the bank or kicked around.

The whistles of the steam shovels should be used for signaling warnings when blasting is to be performed. When the blasting gang is to set off a blast, it should request permission by a certain signal on the nearest shovel, which should be answered by a control whistle at some prominent point, and the blast should not be exploded until this whistled permission is obtained. It is preferable that all the shovels have differently toned whistles so that all the employees in the pit will know at what point the blast is to be expected. Shelters in sufficient quantity should be provided at accessible points. These are conveniently made of sheet steel in such a design that they can be transported on cars and handled by cranes as on wreckers.

Care should be exercised in breaking bowlders near the shovel either by block-holing or by "bulldozing." Only one such blast should be set off at a time and in general block-holing is preferable to bulldozing. A certain amount of blasting is often carried on by drillers, either company men or contractors, near or in the open pit. Their handling of explosives should be controlled by the mine and made to conform to the company regulations.

THE SHOVEL.

The steam shovel is a small power plant. Many of the dangers besetting work around the shovel are those to be expected in a power plant. There are, in addition, risks of accident to the gang around the shovel, from falls of material out of the cars and the shovel dipper and from crushing by the dipper. Around the churn-drilling machines, also, there is danger of injury from the moving machinery and from miscellaneous causes. As for the shovel, the boiler should be of good quality, handled and inspected like any stationary boiler; moving parts should be covered or railed off when practicable; good illumination should be provided; running boards, walks, stairs, and ladders should be furnished and kept railed, in good condition, and free of obstructions; the machinery should be inspected regularly by the engineer. The shovel should not be moved without signaling; it should be blocked or chained when on a grade. The men working around the shovel should be kept away from in front of the machine as much as possible and out from under the dipper; they should watch out for chunks rolling from the cars being loaded. Nobody whose business does not call him there should be allowed around the shovel.

FAILS OF PERSON.

Falls of persons are far less likely to occur in an open pit than underground, and when they do occur they are less likely to result seriously. They are, however, possible. In winter snow and ice may cause slipping and falls of greater or less seriousness. Where the exigencies of the operations require the men to work on the sides of the banks, they are in danger of rather serious falls. The sides of the pit are often so steep that a fall from the edge might cause death. In general, precautions should be taken to make travel in and around the workings as safe as possible. Stairs should be placed where necessary and both they and any trails that may be in common use, should be kept clear of ice and snow if practicable. Where men must work on dangerous banks, they should be required to equip themselves with ropes. Dangerous points on the sides of the pit preferably the whole perimeter—should be guarded by a substantial fence; and similarly dangerous points within the limits of the pit protected in the same way.

Another hazard accompanying open-pit work is that of falls into auxiliary or preliminary workings such as shafts and test pits. When possible, these should be blasted in after abandonment; otherwise they should be guarded as this code provides.

LOCOMOTIVES AND ORE TRAINS.

Steam-shovel mining resembles railroad operations in many respects. Many of the accidents that occur in steam-shovel pits are the same that occur on railroads and the precautions to be taken against them are the same that railroads observe. Precautions are necessary against collisions, against runaway trains on the steep grades and sharp curves that usually exist, and against the danger of running down men who may be walking on the track. To avoid this last danger trails and walks should be provided apart from the railroad tracks and their use insisted upon. Dangerous methods of coupling and dangerous methods of boarding cars or engines should be forbidden. Nobody should be allowed to ride the ore trains except the train crews. Proper clearances over cars and on the sides should be provided and material should not be allowed to be piled so close to the track as to be dangerous. The men selected to work on the track should be intelligent and alert and should be taught extraordinary caution in looking out for trains. Frogs should be blocked and signs provided at crossings. There should be a strict adherence to safe practice in regard to the use of headlights and rear lights on locomotives and trains, to the sounding of whistles, and the ringing of bells. While the railroad hazard in open pits is perhaps greater than any other, it is impossible to specify here the many rules that should

be observed. Railroad codes covering the matter in detail are available.

Illumination of steam shovels at night is frequently effected by gasoline or by acetylene. Both of these are dangerous to handle. Precautions should be taken against fire and explosion. All filling of cans and charging of generators should be done in the daytime and lights should not be permitted where there is danger of leakage. Where gasoline torches are used they ought to be substantial. Safety cans are advisable for transporting gasoline.

There is a certain amount of danger attached to dumping the stripping cars, and somewhat less to discharging the ore cars when the contents are frozen or sticky. Dangerous practices in performing these operations should be specifically prohibited.

A steam-shovel mine is usually a large property; the locomotives and shovels and cars are subject to hard usage and a great deal of repair work is necessary. This entails somewhat extensive shops, together with a roundhouse. In such shops the usual machine-shop hazards are present and should be guarded against.

CONCLUSION.

This rather brief outline of the conditions appertaining to open-pit mining and the precautions which are considered advisable, must suffice for the time being instead of a specific code. A more detailed study of this rapidly developing system of mining and a comparison of data more extensively collected will undoubtedly in time make it feasible and desirable to frame a safety code applicable to the Western copper mines, the Lake Superior iron mines, and various smaller mines of several metals in other parts of the country.

PREVENTION OF UNDERGROUND FIRES.

FIRE DOORS.

The menace to human life from an underground fire lies in the products of combustion. The smoke and gases circulating through the mine workings may overtake the men in unexpected places and not infrequently trap them by cutting off an exit which would otherwise be an avenue of escape. Eddy currents enter blind workings and reversals of the direction of ventilation make upcast shafts of those previously downcast and vice versa, often with fatal results. It follows that if the direction of ventilation could be positively controlled and the fire isolated, the danger to human life would be vastly decreased. Such control and such isolation could be had by a complete installation of fire doors. Fire doors are not at all in common use underground, probably because the danger and the frequency of mine fires are not yet fully appreciated. The committee has

prescribed the use of such doors under certain conditions. The provision would have been made more sweeping but for the fact that little information on the subject of fire doors in metal mines is obtainable owing to their infrequent use, and the committee is unwilling to stipulate more elaborate and general installations on purely theoretic grounds.

In a mine where the danger of fire is at all serious, a generous equipment of fire doors is wise insurance. They offer many advantages. By shutting off ventilation to the manway used for the egress of the miners, they provide a safe exit in spite of the fire. By hindering the air current they decrease the draft to the fire and thus retard its burning. Finally they interpose obstacles to the spreading of the fire, as through timbered drifts. An ideal fire-door equipment would consist of fireproof doors, quite tight against the passage of smoke or air, arranged so as to close easily and stay closed, but capable of being opened by a man from either side. They should close automatically by the melting of a fuse when the temperature in the vicinity rises above a certain point and they should be capable of closing by means of electricity or compressed air or by other mechanism from the surface or from a distance. They should be in sufficient number and so disposed that every entrance to the mine could be completely isolated from a supply of air or from the entrance of smoke, and the mine stopes and other workings should be divided into relatively small sections which could be similarly isolated.

This outline of a complete installation is here included chiefly for the suggestions contained. Even if the efficacy and the practicability of the devices and the scheme were proved, the vexatious question would arise of when to insist on the requirements. The fire hazard varies tremendously. It would be absurd to prescribe so elaborate an installation for all properties. In many cases, especially in the case of mines that have been worked for many years, the relations of the shafts, tunnels, stopes, and other workings become so complex that complete protection by the means of fire doors would be almost an impossibility. Old workings that open to the surface, such as glory holes, are peculiarly baffling in this respect. The committee has therefore contented itself for the time being with requiring that in timbered mines, shafts used as manways be protected with fire doors, so that a safe exit for the men shall be maintained, and that the doors be capable of being made tight but need be capable of closing by hand only. Such an arrangement still contains elements of risk of course, since a fire may gain such headway that the doors are inaccessible through the smoke and are then utterly useless. In the High Ore-Modoc fire of the Anaconda company, described in Chapter XI, men were overcome just after closing a fire door in one of the levels. To those desirous of installing a more perfect protec-

tion, the committee would suggest that the next step would be to provide the doors with some device to permit their being closed from a distance or to close them automatically with a rise in temperature. It is essential, however, that the doors be of such a pattern that they can be opened from either side and will not trap men behind them.

This particular provision has been framed to cover shafts only. In the case of tunnels, the code requires that a door be provided which can be closed by pulling from the outside of the workings.

The greatest necessity for the fire door arises in the case of two connecting mines, especially where one or both may depend on the other for a secondary outlet. In fact it is possible for a mine with only one outlet actually to add to its hazard by connecting its workings to neighboring workings. This would be the case, for example, if the first mine contained little timbering and the second were heavily timbered, especially if the outlet of the second became a downcast. The advantage to the first mine of having two outlets might be more than offset by the risk of a fire starting in the second mine and pouring smoke and gases into the first. One mine by this arrangement not only adds the hazard of its neighbor to its own hazard, but is also helpless in the face of careless practices by this neighbor. For this reason it is particularly urged that fire doors always be installed in every connection between neighboring mines.

SPRINKLERS.

In considering the safeguarding of mines against underground fires, the committee directed its attention to the possible introduction of the automatic sprinkling system, which has been so highly successful in reducing the fire loss among industrial plants in the United States, especially in New England. After making some inquiries, the committee felt that it might summarily dismiss the present consideration of automatic sprinklers, for the reason that nothing appears to be known about their application underground. The committee's dismissal of them does not by any means imply a condemnation of them, but means simply the nonexistence of data permitting the formulation of any opinion about them. The advantages that they may offer underground and the conditions of their application are well worth experimental investigation.

There is another type of water sprinklers, namely, the nonautomatic or "open" sprinklers. These were used as fire protection in mills long before the automatic sprinklers were invented, and are still in use to a limited extent. These devices are known as "open sprinklers," and having no seal at the valve outlet they are not automatic in action, but depend upon the human element to render them effective by the operation of opening a valve through which water is conveyed to the distributor; but even with this disadvantage,

the open sprinkler has so often proved its value as a reliable fire stop, as to warrant its introduction as a means of protection against fires. This system finds application especially in protecting structures from attack by flame originating in adjoining structures, and they render their protection by the delivery of a volume of water against the outside walls, upon the cornice, and over the front of the windows of the building to be protected, thus forming a water curtain as a fire-stop to the attack of flame from the burning exposure. The committee finds that such open sprinklers are already used to some extent in mining practice, especially for the protection of timbered shafts used as manways.

The committee also finds that the actual use of such sprinkling systems in shafts is under the suspicion of causing reversals of air current, with resulting loss of life. Although such reversal has not perhaps been actually proved, there is indeed the possibility that such may happen and that there may be fatal results therefrom. An examination of some of the accounts of mine fires given in Chapter XI will inspire some ideas on this subject. The committee was of the opinion that too little is known about the use of sprinklers as fire protection underground, to permit of the formulation of any strict rules respecting them, and is further of the opinion that the subject in question must be approached with a good deal of caution. However, there was one case where the committee considered that the installation of sprinklers might be positively prescribed, this being the case of a mine opened by a single shaft without communication, wherein a reversal of air current would be impossible. The committee was wishful to prescribe that every mine should have two outlets, but such is admittedly impossible in all cases. One of those cases is the very deep mine in its development stage. Some pressure was brought upon the committee to recommend two outlets even in that case, but without conceding that very radical proposal, the committee tried to meet it by prescribing that in such a case the shaft, if timbered, should be provided with a water-sprinkling system.

SURFACE CAVES.

One question of practice which the committee found entirely insoluble was that in regard to stoping near the surface. This is a mining operation which frequently involves a great deal of risk, yet one that is also frequently necessary. It is carried on under conditions so variable that any attempt to regulate it by provisions of general application would be sure to work hardship to a quite unwarranted extent. It was thought best therefore to leave the question open, one to be settled by those immediately concerned in any case where it might arise.

Stoping too near the surface manifests itself in the form of a surface cave or subsidence. Such a cave will usually involve more destruction of property than loss of life. It is hence particularly a question of commercial expediency which probably may be left to the discretion of the operator without unduly jeopardizing the safety of the miners. The fact that under the operation of the compensation laws which are so rapidly increasing in number, loss of life, and injury to person among the mine employees is a fixed and unavoidable charge against operations, tends to make these commercial considerations coincide more closely with questions of personal safety and thus still further decrease the risk to the men.

The judgment of the operator or his officers is not of course infallible. In the desire to extract the last pound of valuable ore he may take too great chances and destroy surface improvements worth more than the ore that would otherwise have been left in the ground. Instances of this are known. In Chapter XI there is given a short account of the cave that forced the abandonment of one of the Goldfield Consolidated mills. It can not be stated, without definite figures, that this was an ultimate loss to the company, but it is easily seen that it might be so.

In this particular accident men were killed, but they were killed underground. The fact that the cave was near the surface probably had nothing to do with their death. Indeed, for the same quality of rock, it is easier to support workings near the surface where the load is lighter than at a depth of several thousand feet. So far as underground accidents follow from stoping too near the surface, they are provided against by this code. It is regulations against surface accidents only which have been left unspecified. It is presumable, without knowing the exact facts, that if this Goldfield stope cave had occurred somewhere on the lower levels of the mine, the miners would have been killed in the same manner.

The subject of surface subsidence in which the property of others than the operating company is involved is one of the greatest moment but one beyond the scope of this report. It is much to the fore now in the anthracite region of Pennsylvania.

RELATIVE HAZARDS OF THE CAVING SYSTEM.

One of the best and most economical systems of metal mining involves stoping very near the surface indeed. For in the caving system or in any of its variants, such as top slicing, surface subsidence is expected and provided for. In fact a relatively valueless surface overlaying the deposit to be mined is an essential to the adoption of the system. This brings up the question of the safety of the caving system in respect to underground operations as a whole. The safety

or danger to the miners has not been usually considered in determining whether or not to adopt this method. Questions of commercial expediency have been the determining factors. This must have been so necessarily; for reliable data on the relative safety of this and other stopping methods are not available. The only bit of evidence on the point known to the committee is the fact that the death rate on the iron ranges was formerly fairly high considering the fact that much of the work there is carried on in open pits by steam shoveling, which is considered rather safer than underground work; and the bulk of the underground ore from these districts is, of course, the result of some form of slicing or caving. But the statistics from which death rates are computed have not been collected with sufficient care to make it at all safe to base conclusions on small differences in rates. Furthermore, many other factors might have been responsible for this rate, admitting that it is high, such as the character of the labor, the attitude of the operators, etc.

Extraordinary accidents are of course possible. Such was the Miami cave, wherein the air blast set up, and not the falling material itself, caused the fatalities that occurred. But no conclusions as to the relative safety of a method can be postulated on unusual and isolated occurrences of this nature. The only statement that can fairly be made is that there is nothing to show that the caving system is either safer or more dangerous than other stopping methods.

If it is attempted to analyze the question without reference to results in practice, it would appear a risky business at first glance to carry on mining by deliberately bringing about what it is usually attempted to avoid, namely, the caving of the back. The very fact that it is deliberate, however, robs it of most of its danger. The caving is directed and controlled with a good deal of certainty. The attention of everybody, furthermore, is directed to this point in the operations, the slightest sign of giving way is remarked and interpreted. Logically the result would be to decrease the danger of small falls of rock or ore, which are the most prolific source of injury underground. Work under a great mass of constantly moving ground must, however, involve a good deal of risk under any conditions. So far as hoisting accidents, blasting accidents, and falls of person are concerned, there would seem to be nothing in the caving system either to increase or to decrease their frequency. One hazard there is which is certainly increased where the mining method involves the formation of a mat of timber, namely, the risk of fire. The timber mat in a mine worked for some time may attain a thickness of several hundred feet. A fire once fairly started in this mat would be most difficult to extinguish; a certain amount of rock and earth would be mixed with the timber but not enough to prevent the wood from burning. The situation might even be such that the fire could not

be extinguished even by flooding. This increased fire risk, however, does not necessarily involve an increased risk to human life. Such a fire would usually be slow-burning and not of the kind whereby men are trapped and suffocated, not so dangerous as a small fire in or near a shaft. The property loss would be its most serious result.

MINE VENTILATION.

The difficulty of prescribing equitable regulations covering the subject of ventilation has been touched on in a footnote. Quantitative restrictions on temperature and humidity and on the percentages of carbon monoxide, carbon dioxide, and the nitrogen oxides in the mine air should be varied to conform with the conditions in many different classes of mines. It is questionable whether any one State even could frame a single set of regulations to apply equitably to all the districts within its boundaries. Under some systems of mining it is much easier to keep the air of the stopes in good condition than under others, and there may be also profound differences in natural conditions. A possibly successful solution of the problem would be a division of the mines or districts into groups according to the relative difficulties of providing ventilation. The requirements for each group could then be made more or less strict as the conditions justified.

A timbered mine is usually harder to ventilate than one which is untimbered, and the greater the size of the extraction openings, the simpler is their ventilation in general. Oxidizing sulphide ores, though not perhaps introducing the objectionable gases into the mine atmosphere, operate to raise the temperature sometimes to an unbearable degree. Great depth, decaying timbers, proximity to areas of dying vulcanism, crushing of rocks, and mine fires have a similar effect. The products of blasting explosions, of illuminating combustion, and of underground fires, the exhalations of men and animals and the oxidation of timber—these not only vitiate the atmosphere by the substitution of irrespirable gases for oxygen but also raise the temperature. Marsh gas is not unknown in metal mines and carbon dioxide is frequently found present in the rocks. The intrusion of the latter gas is often peculiarly troublesome, as in the Cripple Creek district where it adds a new problem to metal mining. A consideration of these many variable factors will indicate the reasons of the committee for refusing to include in the code strict quantitative regulations as to the air to be furnished per man and per animal, the temperatures permissible, the quantities of noxious gases to be allowed, etc.

It has seemed equally inadvisable to prescribe any special means to be adopted for securing suitable ventilation. In many properties natural ventilation supplemented with a little compressed air after

blasting is entirely sufficient. In others, forced ventilation of some sort, in whole or in part, is necessary. Metal mines are coming more and more to an appreciation of the value of the fan. In one property where difficulty was encountered in getting enough fresh air to the working places, the installation of a fan not only led to a saving on the use of compressed air sufficient to pay for the installation in a short time, but also increased by about 50 per cent the efficiency of the miners in the stopes where the worst conditions had prevailed.

As American metal mines get deeper, ventilation becomes more necessary and more difficult and attracts more attention. A good deal of study of the subject can be expected and changes in practice are probable. It may be that when operations have been readjusted on a new basis, additional regulation on the subject of ventilation will be desirable.

USE OF GASOLINE UNDERGROUND.

As has been stated in Chapter III, the committee is strongly opposed to the use of gasoline underground when it can possibly be avoided. Speaking broadly, gasoline is a more dangerous substance than most of the blasting explosives, and distillate, kerosene, and the other liquid fuels used in internal-combustion engines are less dangerous only in being less volatile. Gasoline in particular introduces risk in a number of ways. If an explosion occurs, it not only is liable to injure those in the immediate vicinity, but may set fire to timber and may generate sufficient noxious gas to suffocate all or part of the men underground. An explosion may result from a collision or from the ignition of either liquid or vapor while the gasoline is being handled. Such ignition may cause a fire without an explosion, which, however, would be equally dangerous. The exhaust from an internal-combustion engine, furthermore, is itself an element of risk unless safely conducted outside the mine workings. Nevertheless, the gasoline engine, and especially the gasoline locomotive, seems to have a distinctive, if small, field of usefulness; and the committee feels that injustice might result if its use underground were entirely prohibited, although a recently enacted law in Nevada makes such a prohibition, except under certain close restrictions.

In addition to the requirements of the code covering the use of gasoline the committee would also urge that no internal-combustion engines be used at all in mines heavily timbered or where the ventilation is poor. The danger of fire in the first case and the certainty of vitiating the air in the second case make these precautions advisable. The disposal of the exhaust is likely to be a more troublesome problem with the stationary engines sometimes used for hoisting and other purposes than with the locomotive; the latter distributes its products of combustion automatically as it moves around so that the danger of asphyxiation, at least, is diminished. If the exhaust of a stationary

engine has to be piped any distance to a point where it will do no damage, the back pressure is likely to reduce seriously the power of the engine. It is noteworthy that the manufacturers of gasoline locomotives insist on adequate ventilation where their machines are to be installed.

Another precaution that should be observed is that in regard to the use of naked lights where there is danger that gasoline vapor may be present. It would be desirable to use only electric lights anywhere around the engine. It is of great importance to keep the engine, tanks, and connections in good shape, but there is always the possibility of a leak having developed since the last inspection. The portable electric lamps are suitable for such work.

Foreign regulations seem to permit the storage of gasoline underground and the filling of supply tanks from the storage tanks, but they hedge the operations about with many stringent rules. At least one mine in this country, one which is opened by a shaft, stores its supply underground in 50-gallon tanks. Here filling of the engine tanks is carried on by electric light only. In the opinion of the committee, however, it is unnecessary ever to store or fill underground. The locomotive manufacturers do not advise it and provide practicable means to avoid it. As for stationary engines, these can also be fitted with the same type of detachable tanks. It would be safer, however, to store gasoline underground than to pipe the liquid down the shaft, as has been suggested.

Around a stationary engine or on a gasoline locomotive, some fire-fighting apparatus should be provided, if possible. This may be dry sand in buckets or heavy mats of felt or similar stuff.

HANDLING MEN WITH INCLINED SKIPS.

A point of minor importance, perhaps, but one deserving some consideration, pertains to the use of skips for handling men on inclined tracks. This practice is not uncommon in small mines, and its prohibition would work real hardship, but it is almost sure to be a source of danger; whenever possible man-cars should be provided and the handling of men restricted to them, including even incidental travel when the shaft arrangements permit. When skips are used for men, it is not uncommon to prohibit riding on the bail, and the committee considered the inclusion of a provision to that effect in this code. The practice is clearly dangerous, but there are objections to prohibiting it. The inside of a skip is usually wet and dirty. It will not hold many men, especially if the incline be flat. Consequently men often, if not usually, prefer to ride the bail and are also often forced to do so in order to get on at all. A true regard for safety will eliminate the use of skips for men altogether.

An illustration of the danger attendant on riding the bail is furnished by two accidents noted and commented on in the Mining and

Scientific Press of October 22, 1910. In the spring of 1910 in the Central Eureka mine at Sutter Creek, Cal., two men were swept from the bail of a skip and killed. At the adjoining South Eureka mine in October of the same year, while five men were being hoisted in a 60 degree shaft, two on the drawbar and three in the skip, the two men outside were swept off and fell to their death. Curiously enough the parallelism extends even to the causes of the accidents. In each instance a loose strap rail was to blame. This brings up the question of the use of strap rails in inclined shafts. It appears that in this district trouble was had with a swelling foot wall, and strap rails were used as a safety precaution. It was believed that they would conform more easily to the irregular and constantly changing configuration of the ground than would the heavier T rails. It is supposed that in the case of the two accidents the spike holes got so worn that the spikes no longer held the strap, which, loosened thus from its backing, was caught by the skip lip and wrenched further loose so as to fling the men from the bail. Under the conditions existing here it may be possible that the strap rails were safer than T rails would have been, but the great ease with which they do come loose makes them in general far more dangerous. It would seem hardly necessary, however, to prohibit their use, as they are now almost an anachronism, and where found they will usually be in mines too small to come within the scope of the code here proposed.

HOISTING ROPES.

GENERAL STATEMENT.

No section of this proposed code was the subject of more discussion and none was found more difficult to frame than that governing the use of hoisting ropes. It was felt that the matter was one of great importance, inasmuch as in most mines the lives of many men for several hours in each day depend on the reliability of the ropes used to hoist the cages. This is well recognized by operators and in general the greatest care is exercised in inspecting the ropes and maintaining them in good condition. This probably results from the fact that the danger is obvious to even the most inexperienced. It is furthermore true that inspection of a rope is relatively simple, that the precautions against accident are easy to take and, particularly, that a good wire rope gives ample warning of being unsafe.

Nevertheless, distressing accidents do occur from failure of ropes and practice in the methods of caring for, inspecting, and retiring hoisting ropes varies greatly. It was felt that standardization was highly desirable in regard to the methods of rope fastening, to the ratio between rope and sheave diameters, to safety factors and the method of determining them and to the basis on which a rope should be retired from service. It was found, however, that there was

not obtainable, in this country at least, sufficient accurate data on which regulations as specific as desirable might be based. The committee therefore contents itself with the somewhat general provisions found in the code, with the expectation that investigation along this line will sometime make possible a revision in the direction of more specific regulation.

In order to obtain technical information as complete as possible on this question of hoisting ropes, the committee consulted with the leading rope manufacturers of the country and finally arranged for a conference at which representatives of the several manufacturers met with the chairman of the committee and discussed the matter in detail. Some of the most perplexing points were then referred to a committee of the manufacturers for further consideration. The general discussion and the report of this committee have brought out facts that are of great interest and technical value aside from their bearing directly on the question of safety. The results will be incorporated in this discussion.

SAFETY FACTOR.

In considering first, the matter of safety factors, questions arise as to what safety factor to require, what stresses to include in the divisor in determining such factor, and how to ascertain the dividend or ultimate strength of the rope. As regards ascertaining the ultimate strength of the rope, the committee is convinced that it is both safe and economical to rely on the tables furnished by manufacturers in their catalogs or elsewhere. Since the strength of the material in the wire and the method of assembling the wires into the rope both have a bearing on the rope's strength, it is plain that there is much opportunity for variation. Nevertheless the product turned out is remarkably uniform and reliable. Each individual rope is not tested; but tests are made on ropes of the several constructions and classes of material, and these are constantly checked. The tables in the catalogs perhaps rather understate than overstate the strength of a rope, but the error is slight, is on the right side so far as safety is concerned, and is not of enough consequence to affect seriously the matter of costs.

The total stress in a hoisting rope is made up of several factors. The most important of these is the dead load of the vehicle, its contents, and the rope itself. Added to this is the stress caused by starting and acceleration; this may be extremely high if the hoisting engineer is reckless, careless, or ignorant; the practice of starting with a slack rope, sometimes followed where the hoist is underpowered for its work, may put extraordinary tension on the rope. Then there is the bending stress when the rope takes the curve of the sheave, drum, or reel or straightens out when leaving it. These three stresses are more or less calculable. Finally there are extraordinary

stresses, such as those that occur when a shaft vehicle is pulled at full speed into a constriction of the shaft or when it is overwound. These of course may be of such magnitude that no rope could be expected to withstand them. It is also true that high-speed hoisting is harder on a rope than low-speed and causes more rapid deterioration, a consideration of importance in determining safety factors.

What stresses shall be considered in calculating the rope safety factor? While those due to acceleration and bending are determinable, they are not easily so and it seemed to the committee that it was desirable to make the provisions of this code easy of analysis and enforcement. It was therefore decided to calculate the safety factor on the basis of dead load only, and make it proportionately greater.

It is evident that with so many different elements affecting the service of a rope, no single safety factor could be selected which would be effective and fair for all cases. It was the sense of the majority of the manufacturers' representatives that the service of ropes should be classified, taking account of the depth of the shaft, whether it be vertical or inclined, wet or dry, whether the hoisting be fast or slow, whether the water be "acid" or not, etc., and that the safety factor and other requirements should be varied to suit these several classifications. Such a course would be theoretically correct, but would result in provisions too complicated for a code such as this. The code therefore imposes a minimum safety factor for all installations and another below which no rope shall fall and remain in service; very deep shafts it exempts altogether.

However, the manufacturers' committee, of which mention has been made, went carefully into some phases of this matter and compiled some tables which represent good practice and constitute excellent rules for mining operators to follow. In the first place, the safety factor is varied according to the depth of the shaft, one is specified for new ropes and another below which no rope shall be allowed to fall. The factor is to be determined by dividing the manufacturers' figures for breaking strength by the dead load, just as prescribed in section 34.

TABLE 1.—*Hoisting-rope safety factors for various depths of shafts.*

Length of rope, <i>Ft.</i>	Minimum safety factor for new rope.	Minimum safety factor when rope must be discarded.	Percent- age re- duction.
700 or less.....	8	6.4	20
700 to 1,000.....	7	5.8	17
1,000 to 2,000.....	6	5.0	16½
2,000 to 3,000.....	5	4.3	14
3,000 and over.....	4	3.6	10

The several factors given in Table 1 are based on an actual safety factor of four and are made greater for the shallower shafts because in them the acceleration stresses and a good many of the possible extraordinary stresses are normally greater. In deep shafts it is well recognized that the spring of the rope acts to eliminate the shock of starting and to decrease the stresses of acceleration.

PERMISSIBLE HOISTING SPEED.

Then for the several depths of shaft, or lengths of rope in the shaft, maximum permissible hoisting speeds are specified. These are given in Table 2.

TABLE 2.—*Permissible hoisting speeds when specified safety factors are used.*

Length of rope in shaft.	Maximum hoisting speed.	Length of rope in shaft.	Maximum hoisting speed.
<i>Feet.</i>	<i>Ft. per min.</i>	<i>Feet.</i>	<i>Ft. per min.</i>
500 or less.....	1,200	2,500 to 3,000.....	2,500
500 to 1,000.....	1,600	3,000 to 3,500.....	2,750
5,000 to 1,500.....	2,000	3,500 to 4,000.....	3,000
1,500 to 2,000.....	2,000	4,000 to 4,500.....	3,250
1,000 to 2,500.....	2,250	4,500 to 5,000.....	3,500

PERMISSIBLE ACCELERATION OF HOISTING SPEED.

Finally, a table of permissible accelerations is given for various hoisting speeds which are not to be exceeded with the safety factors specified. These are shown in Table 3.

TABLE 3.—*Permissible rates of acceleration for certain hoisting speeds and safety factors.*

Speed.	Maximum acceleration.	Minimum time of acceleration in which to attain speed corresponding thereto.	Speed.	Maximum acceleration.	Minimum time of acceleration in which to attain speed corresponding thereto.
<i>Feet per min.</i>	<i>Feet per sec.</i>	<i>Seconds.</i>	<i>Feet per min.</i>	<i>Feet per sec.</i>	<i>Seconds.</i>
500 or less.....	4.16	2	2,000.....	8.33	4
750.....	4.16	3	2,500.....	8.33	5
1,000.....	5.55	3	3,000.....	8.33	6
1,250.....	5.95	3½	3,500.....	8.33	7
1,500.....	6.25	4			

DIAMETER OF SHEAVE.

The figures take care of the variables of depth of shaft, hoisting speed, and acceleration stresses. The question of bending stresses is not considered, nor is it in section 34. The bending stress of course increases as the diameter of the sheave or drum decreases. It could be kept from becoming too great by specifying minimum permissible

ratios between sheave and rope diameters. The increase in stress caused by running a rope over too small a sheave is unimportant compared with the resulting increase in rope wear, and as explained in the footnote to section 34, considerations of economy can be trusted to prevent the use of sheaves and drums too small for the ropes. If the other provisions of section 34 are followed, the question of size of sheave will take care of itself.

The economical ratio between rope and sheave diameters varies with the character of the wire in the rope and the type of construction. A pliable rope can run economically and safely over a smaller sheave than can a stiffer rope. The committee has reports of excellent results from the use of a $1\frac{1}{4}$ -inch rope over an 84-inch sheave, which gives a ratio of 66, whereas in many cases, especially in the case of deep shafts and long ropes which usually are of necessity stiffer, a ratio of 100 has been recognized as not too high.

In connection with the question of sheave diameters, one point should be noted, namely, that it is possible to make the ratio too high under certain conditions, or more correctly stated, it is possible to make the sheave too heavy. This is the case frequently with turn-sheaves, guide pulleys, rollers, etc., on which the arc of contact and the compression between sheave and rope may be so little as to allow excessive slip, the rope failing to rotate the sheave easily. Of course such a condition would cause wear and tend to deteriorate the rope faster than would the use of a smaller, lighter sheave. To decide on a suitable size of sheave under such conditions the following rule is serviceable. Suppose that a ratio between sheave and rope diameters of 72 is considered permissible. Then when the deflection angle of the rope is less than 90° , that is, when it has less than 90° of contact arc on the sheave, the diameter of the sheave shall be eight-tenths of the deflection angle times the diameter of the rope. Thus as the deflection angle or arc of contact becomes less, the size of the sheave decreases. For a 45° -deflection angle, a 3-foot sheave is required for a 1-inch rope, and for zero degree no sheave is required, a rubbing board alone being sufficient.

INCLINATION OF SHAFT.

The classification of rope service on the basis of vertical or inclined shafts has not been attempted. It is well recognized that service in an inclined shaft is likely to be more severe than in a vertical. It was felt, however, that considerations of economy could be depended upon here to obtain automatically proper installation, as in the case of diameters of sheaves and drums. It is necessary of course to use rollers so disposed as to reduce wear to the lowest practicable point.

ROPES NOT USED FOR MAN-HOISTING.

It would seem also as if a classification and a distinction in requirements should be made on the basis of whether or not ropes are used for handling men. As a matter of fact in metal mining, it is seldom that a rope is not called upon at some time to handle men, and even if this service be only incidental or occasional, it is desirable that the rope be as reliable as those used strictly for man-hoisting. For this reason the requirements of the code have been made applicable to all ropes except those which are not used for man-hoisting under any circumstances and the breaking of which could not injure anybody. These latter ropes, on the other hand, have been left exempt from all restrictions, their installation and operation being a concern of the operator only.

PERMISSIBLE DETERIORATION OF ROPE IN USE.

It will be noted that in Table 1 the final permissible safety factor is not fixed, nor is the percentage reduction constant. The reason for not specifying a fixed permissible percentage reduction in the code is given in the explanatory note to section 34; a specified minimum reduction would tend to penalize the operator who is willing to install ropes with safety factors above the minimum. The manufacturers' committee, on the other hand, felt that if the initial safety factor be high, the rope should not be allowed to deteriorate so as to bring the safety factor to the same point as when starting from a lower initial safety factor, for such a large degree of absolute deterioration would indicate that the condition of the rope was very bad indeed. The greatest percentage reduction permitted by the manufacturers is 20 per cent, and the code permits 25 per cent. It will thus be seen that the manufacturers' proposed regulations are both more minute and more drastic than the provisions of the code. In drafting the code it was not thought advisable to make the provisions too severe until the questions still unsettled have received more study. It is the intention of this committee to recommend that the United States Bureau of Mines undertake the study of hoisting ropes, probably in conjunction with the manufacturers, and that data be collected by breaking used ropes in testing machines, in order that an improved set of rules can be built up.

The question of when a rope shall be discarded is most difficult to determine. It is discussed to some extent in the explanatory note to section 34. It is desirable that only a certain percentage of reduction in strength be permitted, or else that the strength of the rope be kept above a certain point. The difficulty consists in determining when this point is reached. Probably the most satisfactory way

would be to determine the strength of a rope at regular intervals by breaking tests, but this is impracticable in this country and is furthermore open to the objection that only the end of the rope can be thus tested. The committee has therefore tried to specify certain easily recognized signs for determining when the rope is to be discarded. Chief among these is the number of broken wires occurring in a given length of rope. There are, however, no data on which can be based a close quantitative interpretation of the effect on the rope's strength of the number of broken wires. Furthermore it would be a slow and difficult undertaking to gather and interpret such data. The reasons for this will be set forth later.

There may be said to be five ways in which deterioration of a rope proceeds. First, there is frictional wear; second, there is breakage of wires due to inequalities in even the best material; third, there is the breakage caused by the stress of bending over sheave and drum; fourth, there is corrosion inside and out; fifth, there is fatigue of the steel caused by its passing its elastic limit and accelerated by bending and by rapid hoisting. All of these effects finally take the form of broken wires. For this reason the committee considers the appearance of broken wires the best single sign to follow in deciding when to discard a rope. The number of such wires permitted is intended to correspond to a reduction in strength of about 25 per cent, but as stated, this correspondence is only approximate and probably exists only in ropes of standard construction. There are two difficulties in the way of expressing quantitatively by the number of broken wires a percentage reduction in strength. The first is that the position of the broken wires in the rope is of the greatest importance in determining their effect on the rope's strength. The second is that ropes of a great variety of construction are in use and in each type the effect of the breaks is different; this is especially true when the wires are of different diameters.

As regards the different types of rope, whereas those used for hoisting are generally made of 6 strands with 19 wires to the strand, there are sometimes used ropes with strands consisting each of 7, 12, 13, 14, 15, 16, 19, 37, and 61 wires. Of the 6 by 19 construction, as it is called, there are again several different types. What is commonly considered standard is that in which the strand is composed of 7 inside wires with the 12 outside wires laid around these, alternating in the size of their diameters. In this construction the twist of both outside and inside groups is the same and the alternation in size of outside wires is necessary to prevent 6 of them from sinking into the valleys between the inside wires and making a rough-surfaced strand. In another method of construction the wires are all of the same size, but the twist is made different. In the "scale" construction 9 small inside wires are surrounded by 9 large outside wires

of uniform size, about twice the diameter of those inside. In a fourth type the valleys of the inside group of wires are filled with 6 very small annealed filler wires and the 12 outside wires are all of one size. There are further to be considered ropes of flattened and triangular strands which use wires of various shapes and sizes, nontwisting ropes, steel-clad ropes, and many ropes of special constructions.

As regards the effect of the position of the broken wires, it is evident in the first place that the binding action of the twist is such that if a number of breaks occur separated some distance from one another, the diminution in strength may be only that due to the elimination of one wire. Therefore the committee has specified that the breaks are to be counted within the distance of one "lay" or turn of the rope, within which distance the binding action need not be considered. A greater difficulty arises from the fact that the disposition of the breaks in the strand and their occurrence in one or several strands modifies their effect on the strength of the rope.

In connection with this matter of the location of the breaks, some tests made under the auspices of the manufacturers' committee are of interest and value. They are not at all conclusive but serve excellently to illustrate how complicated the problem is. The tests were made on a plow-steel rope of standard 6 by 19 construction, 1 inch in diameter. The results with explanations are presented in Table 4.

TABLE 4.—*Tests of hoisting rope with cut wires.*

Test No.	Number of strands cut.	Number of wires cut in a strand.		Percentage of metal area.	Estimated strength after cutting. ¹	Breaking strength.		Strands broken.	
		Large.	Small.			By actual test.	Percentage of original strength.	Number.	Point of breakage.
					<i>Pounds.</i>	<i>Pounds.</i>			
1.....	6	1	.....	93.02	74,441	74,100	92.60	3	Center.
2.....	6	1	1	89.56	71,887	72,390	90.46	2	Center.
3.....	6	2	1	82.62	66,119	67,640	84.50	1	Center.
4.....	6	2	2	79.20	63,375	67,010	83.74	3	Center.
5.....	6	3	2	72.23	57,793	62,020	77.51	2	Center.
6.....	6	3	3	68.79	55,046	59,620	74.51	2	End.
7.....	6	4	3	61.83	49,474	55,575	69.45	2	End.
8.....	1	6	6	89.56	71,807	60,090	75.09	1	Center.
9.....	6	4	3	61.83	49,474	58,180	72.71	2	Center.
10.....	2	6	6	79.20	63,375	54,090	67.60	2	Center.
11.....	6	4	3	61.83	49,474	58,850	73.54	3	Center.
12.....	2	6	6	79.20	63,375	72,250	90.29	2	Center.
13.....	1	6	6	89.56	71,837	76,700	95.85	1	Center.
								1	End.

¹ Strength before cutting was about 80,000 pounds.

NOTES.

Test 1.—One large wire cut from each strand. Each wire cut three times. End cuts a distance of two rope lays from center cut. Each series of cuts in same circumference.

Test 2.—One large and one small wire cut in each strand on same axis. Each wire cut three times. End cuts a distance of one rope lay from center cut.

Test 3.—Two large wires and one small wire cut in each strand in same manner as in test 2.

Test 4.—Two large and two small wires cut in each strand, same manner as in test 2.

Test 5.—Three large and two small wires cut in each strand, same manner as in test 2.

Test 6.—Three large and three small wires cut in each strand, same manner as in test 2.

Test 7.—Four large and three small wires cut in each strand, same manner as in test 2.

Test 8.—Three sets of four wires each or all outside wires in one strand only cut. Wires cut only once. Each set of four wires cut were a distance of one strand lay from each other.

Test 9.—Same as test 7, except each wire cut only once.

Test 10.—Same as test 8, except two strands were cut.

Test 11.—Four large wires and three small outside wires in each strand cut. One large wire in each strand cut in center in same circumference. One end cut, two large and one small wires; other end cut two small and one large. Distance from center to end cuts one strand lay. Each wire cut only once.

Test 12.—Same as test 10, except that each set of cuts was a distance of one rope lay apart.

Test 13.—Same as test 8, except that each set of cuts was a distance of one rope lay apart.

It should be noted that the rope tested was new and the diminution in strength is purely that from cuts or breaks, corrosion and abrasion not entering in. Furthermore the tests were static, the effect of passing over sheave or drum being neglected. The 13 tests can be divided roughly into two classes. Nos. 1 to 7, 9, and 11 had the cuts symmetrically located by strands, that is, there were wires cut in each of the six strands. Nos. 8, 10, 12, and 13 had the cuts unsymmetrically located by strands, that is, one or two strands had wires cut, the other strands being left intact. Those of the first class gave results about as might have been expected, that is, the more cuts the less strength. Those of the second class gave results that seem discordant until analyzed. In test 8, for instance, only one strand had wires cut and these cuts being one strand lay apart the binding action was not enough to prevent the strand from elongating, so that an undue share of the stress was put on the other five strands, which were thrown out of their position of strength, the shape of the section being altered. Before they could re-form into a position of uniform tension the wires were attacked severally and rupture resulted at a point below the calculated strength of the section, evidently because part of the wires were momentarily out of commission. In test 13, on the other hand, the cuts were also all in one strand, but they were a whole rope lay apart and therefore the binding action was such as to give an ultimate strength above that calculated for the uncut wires.

Although many of the difficulties evidenced by the apparent discrepancies in these tests may be overcome by specifying that the breaks and worn wires lie within the limits of one rope lay, as in section 34, it is nevertheless evident that the relation between broken and worn wires and ultimate strength is dependent on a host of variables, and it must be repeated that the requirements of section

34 for discarding are not intended to be strictly quantitative. They merely constitute a useful criterion for determining when a rope is no longer safe.

It is the opinion of the manufacturers that many mine superintendents or officials responsible for the operation of the hoisting ropes are overzealous in the matter of discarding and in many cases do not get full service from their ropes. The manufacturers are probably correct in their stand and are evidently desirous of turning out the best possible ropes and seeing that these ropes get the best possible treatment. Nevertheless, the committee is not inclined to recommend that operators be any less zealous in the matter of discarding ropes. The slight saving in hoisting costs would not justify the possibility, however slight, of an accident caused by running a rope too long. Where practice errs on the side of safety, it is well to leave it undisturbed.

The manner in which breaks occur is of significance. Thus when a new rope is installed there is likely to be a short period, while the rope is taking its set and equalizing tension, during which breaks are relatively frequent. These breaks are of no importance and do not indicate that the rope is wearing out. After the period of their occurrence, the rope will run for some time without more wires breaking. Toward the end of the life of the rope, however, it may happen that the number of breaks begins to increase rapidly. Thus inspection on one day may show one wire broken at a certain point. The next day two may appear there and the third day, three or four. This condition arising is a sign that the rope is going to pieces and should be taken off forthwith. It may also happen that breaks occur before any great wear is visible—this, of course, after the period of initial breaking. Breakage without wear indicates faulty installation of some kind; either the rope is made of brittle wires or it is being bent over too small a drum or sheave.

The section calls for the superficial inspection of hoisting ropes every 24 hours. As to how this shall be performed, the following extract is pertinent:^a

76. The person making the examination stands in a safe position at the collar of the shaft and allows the rope to be slowly raised or lowered through his hand, which is protected by a thick glove or piece of waste. The rope should not be moved faster than 40 or 50 feet per minute; and, while feeling with the hand for any broken wires, the eye of the operator watches closely for any other defects, such as excessive wear, loosening of the strands, straightening of the lay, kinking, or severe corrosion. When anything abnormal is noticed, the motion of the rope should be stopped and the suspected part thoroughly cleaned and examined. If the defect is a serious one, such as the occurrence of two or more broken wires in a short length of the rope, say two feet, the engineer's attention should at once be called to the fact; while, in the case

^a Report of the Transvaal commission on the use of winding ropes, safety catches, and appliances in mine shafts, 1907, p. xxv.

of a lesser defect, a note should be made of its position in the rope, a proper entry legged in the record book, and the engineer duly informed. It is also advisable that the rope should be watched for a short time while it winds on and off the drum and while coiled on the drum, so that the positions of possible pinching or crushing can be located and examined.

ROPE FASTENINGS.

Involved with the question of selecting and caring for a hoisting rope is that of the proper method of fastening it to the conveyance in the shaft. There are two types of fastening in common use, that in which the end of the rope is held in a socket by metal poured in the molten state, the socket being arranged for easy attachment to the shaft conveyance, and that in which the rope is doubled around a thimble, brought back and fastened to itself by clamps or clips. The latter method is probably most widely used in this country, although the former is extremely popular in certain districts, for instance, the copper region of Lake Superior. When the socket fastening is employed, it is customary to use babbitt or some similar alloy for fastening the rope in the socket, the wires in the end of the rope being "broomed out" and doubled back a short distance. Many operators have a profound distrust of this method of fastening, a distrust based partly on records of poor performance, partly on the apparent insecurity of the fastening, and partly on the fact that the essential parts are concealed and it is impossible to know what is going on inside the socket. The committee was, in fact, strongly urged to prohibit this type of fastening altogether. It was unwilling to do so, because the fastening properly made is a good one, because it prevails in many important mining districts, and because it possesses certain advantages, being economical of head-room, a matter of some importance, especially in preliminary operations where buckets are used.

This decision of the committee received entire vindication through the conference with the rope manufacturers, who are strongly opposed to the thimble-and-clamp method of fastening and recommend the socket method under all conditions. The socket fastening which they recommend, however, differs from that in ordinary use in that instead of some metal of the babbitt class, zinc is used to hold the wires and the wires themselves are not doubled back inside the socket but are merely "broomed out." It has been established beyond question of doubt that this is the strongest fastening that can be made. The wires having been previously cleaned with acid, the zinc makes a perfect bond with the steel just as in galvanizing; the wires can not pull out. As final proof of the efficiency of this fastening there is adduced the fact that in testing ropes in machines for ultimate strength, the zinc-filled socket is used and when properly made never fails.

The manufacturers urge against the thimble-and-clamp method of fastening that it is practically impossible to develop by it more than 85 per cent of the strength of the rope, and that the maintenance of even 85 per cent efficiency is difficult. As a rope takes tension, it tends to compress the hemp center and become reduced in diameter; this loosens the clamps or clips that hold it to itself. It is therefore necessary to keep tightening the clamping bolts to prevent the fastening from becoming unsafe. On the other hand, it must be said that the thimble-and-clamp fastening is easy to make and not easy to make wrong, and that it is constantly exposed to view and therefore subject to easy inspection, whereas the zinc joint must be made with care and like the babbitt joint is not readily inspected so far as its internal condition is concerned.

DIRECTIONS FOR MAKING A SOCKET JOINT WITH ZINC.

The following directions for making a socket joint with zinc are given by the manufacturers' committee:

1. The rope should be securely seized at the end before cutting off and an additional seizing placed at a distance from the end equal to the length of the basket of the socket. In the case of large ropes this seizing should be several inches long and wrapped on securely with a special seizing iron. This is very important in order that the lay of the rope may not become untwisted, otherwise the tension in the strands may not be uniform when the socket is applied.

2. Take the end seizing off the rope, leaving the other seizing on. Then cut out the hemp center back to this latter seizing and broom out the wires; they should be all untwisted but not necessarily straightened.

3. Clean the wires thoroughly in benzine, naphtha, or gasoline for the distance that they are to be inserted in the socket and then dip them in a bath of commercial muriatic acid for a period of about 30 to 60 seconds or until the acid has thoroughly cleaned each wire.

4. Dip the wires in boiling hot water to which has been added a small amount of soda to neutralize the acid and insert the wires in the basket of the socket. Be sure that the socket lies with the axis of the rope. If the temperature is below 65° F., warm the socket before pouring the zinc.

5. Seal the base of the socket basket with putty, clay, or similar substance and pour the molten zinc into the basket until it is full. The zinc must not be too hot or it will anneal the ends of the wires, especially of small ropes. About 700° to 800° F. should be sufficiently hot. After the zinc is solidified the socket can be plunged into cold water to cool off. If the socketing is properly done, the rope when tested will break one or more strands between the sockets in a testing machine.

DIFFICULTY OF SPECIFYING FOR CLAMP FASTENINGS.

In regard to the use of the thimble-and-clamp fastening, it was found impracticable to specify any minimum number of clamps or clips to be used, inasmuch as the type of clamp largely determines its efficiency; for this reason the requirement is made that the fastening develop a certain percentage of the rope strength. The operator may satisfy himself of this strength of fastening by actual test or in any way he pleases. He is, however, responsible for any accident which occurs from failure of the fastening, if it be proved that the strength of the fastening was below requirements.

In some mining regions it is customary to use a socket with a bridle-chain clamp attached to the rope above the socket. The use of this additional fastening increases the safety of the attachment and is probably to be recommended, although it is not a practice sufficiently well established to be required in the code.

RENEWING FASTENINGS.

Whether socket or clamps be used for fastening the rope, it is important that the fastenings be made anew every so often. The reasons for recapping are given in the explanatory note to section 34. It serves to bring new parts of the rope to the points subject to maximum deterioration. A somewhat similar effect is obtained by turning the rope end for end, but reversing the rope is left optional with the operator. The question of time deterioration and the permissible life of a rope whether in active service or not is also taken up in the note to section 34.

In order to make the frequency of resocketing correspond to the severity of the service to which the ropes are put, the manufacturers' committee has drawn up a table, to be followed after the average life of three ropes has been determined. The table, No. 5, follows:

TABLE 5. —*Time interval permissible between resocketings for ropes of various expected terms of service.*

Average length of service.	Maximum time between re-socketings.	Average length of service.	Maximum time between re-socketings.
Months.	Months.	Months.	Months.
6.....	1	21.....	3½
8.....	1½	24.....	4
11.....	2	27.....	4
12.....	2	30.....	4
15.....	2½	36.....	4
18.....	3		

OTHER CONSIDERATIONS.

There are certain other considerations in connection with the installation and use of hoisting ropes which are worthy of attention

although for various reasons they are unsuitable for inclusion in the provisions of the code.

Drums which require the rope to be wound in more than one layer cause more rapid deterioration of the rope. Such drums are often necessary but they should be avoided when possible. A large fleet angle in connection with multilayer drums is also undesirable, as causing excessive rope wear. A certain large mining company sets a maximum of $1\frac{1}{2}^{\circ}$ for this angle when the drum carries more than one layer. One rope company advises a lead of at least 50 feet from sheave to drum for each foot of drum face under such conditions.

In connection with the subject of wear from this source, the following observations are of interest.^a

72. Where small winding drums are used to carry several layers of rope, very severe damage is frequently caused owing to the "pinching" effects that occur at the cheeks (flanges) of the drum, where the winding rope is forced by wedge action to turn backward on itself in a riding turn. This can be obviated if the flanges are constructed to a design introduced by Mr. H. C. Behr, consulting mechanical engineer to the Consolidated Goldfields of South Africa, Ltd. In his standard specifications for winding engines, as mentioned in Mr. E. J. Laschinger's evidence, it is provided that:

"The last groove opposite to where the rope is attached shall rise gradually above the other grooves, so as to raise the second layer of the rope gradually and without shock above the first layer. In order to prevent overstraining the drum flange or wedging the rope as it mounts from the second to the third layer, where it can not be assisted by a rising groove in the drum as employed in the case of mounting the rope from the first to the second layer, the drum flange at that point shall be formed with an annular projection sloping at an angle of 45° for the depth of the second layer of rope. Below the sloping part there must be a filling piece shaped along a spiral, so as to fill the space between the edge of the rope and the lower edge of the conical projection of the drum flange, for the purpose of preventing the end of the second layer of rope from being wedged in between the first layer and the foot of the flange."

73. Side friction of one coil of rope on the next coil, as also on the lower coils on which it is bedding, may be produced by too short a lead from the pit-head sheave to the drum. The angularity of the pit-head sheave and the horizontal distance of the drum from the shaft should so conform to the width of the drum that the deviation of the rope is not too great. An angle of 2° on each side of the center line has been found to be sufficient. If this limit is departed from to any extent, there is considerable side friction on the rope and the coiling of the rope on the drum is likely to give trouble. However, in the case of a grooved drum with the rope coiling in only one layer it may be permissible to have more lateral deviation.

Care is necessary when a new rope is uncoiled. This can not be done as it is with a fiber rope, since a wire rope would kink or untwist. If the wire rope is in a coil, this should be rolled along the ground and if it is on a drum or reel, this should be mounted so as to revolve freely and allow the rope to be pulled out.

When a rope is placed in storage, it is essential that it be kept in a dry place free from fumes of any kind and properly protected from the weather. It is advisable also to apply a coating of lubricant to the outside layers occasionally.

^a Report of the Transvaal commission on the use of winding ropes, safety catches, and appliances in mine shafts, 1907, pp. xxiv, xxv.

The pieces comprising the connection of rope to shaft vehicle should be annealed at intervals in order to avoid "crystallization."

It will be noticed that the provisions of section 34 and the discussion of hoisting ropes up to this point appear to pertain solely to round ropes. It is true that many flat ropes are still used in this country, but they are becoming less and less common and new reel hoists are now rarely installed. Furthermore, one of the claims made for the flat rope is its increased safety, due to the fact that its open structure renders it easy to inspect all its wires and diminishes the chance of failure through internal corrosion. It is intended that section 34, so far as it is applicable, shall cover the use of flat ropes as well as of round, but it was felt that the inclusion of special provisions for flat ropes or of distinctions between the two types would greatly complicate the section and would serve little useful purpose. For this reason the question of the installation and care of flat ropes as such has been left in abeyance.

RULES FOR USE OF ROPES.

Some rules put forth by the manufacturers bearing on the installation and maintenance of hoisting ropes are given here. Although they repeat somewhat the provisions of this code and parts of this discussion, their somewhat different and concise form may be found useful.

1. Sockets are recommended for all rope attachments; when properly made they will develop the full strength of the rope.
2. All socket attachments should be made with zinc.
3. All wires should be thoroughly cleaned and fluxed.
4. All wires should be separated and straightened.
5. Four good seizings of iron wire should be placed on the rope, the first at a point from the end of the rope equal to the length of the socket basket.
6. The zinc should be poured when its temperature will cause a pine stick to char and ignite.
7. When the surrounding temperature is less than 50° F., the socket should be warmed before pouring the zinc.
8. At the top of the socket there is a point which is rigid where vibration is arrested suddenly, causing fatigue at that point. Therefore the rope should be resocketed every three months for a speed of 1,000 feet per minute or less and every two months for higher speeds.
9. When resocketing, about 6 feet of rope should be cut off the end and examined for internal corrosion. This length is specified because this part of the rope is subject to the most rapid depreciation. It is advisable, since it brings another section of rope on the head sheave when the cage is stationary.
10. All new hoists should have drum capacity enough to take care of the surplus rope necessary to permit resocketing and allow a minimum of three laps to remain on the drum when the rope is fully out.
11. Clips are not advisable for fastening the rope to the cage, as they do not develop the ultimate strength of the rope and when placed incorrectly may damage the rope to a great extent.

12. Catalogue strengths are to be used in fixing the proper load capacity of a rope.
13. The factor of safety is not to be less than five for vertical shafts.
14. The factor of safety is not to be less than six for slopes and inclines.
15. The head sheaves shall be at least 60 times the rope diameter for 6 by 19 ropes and 90 times the rope diameter for 6 by 7 ropes.
16. All knuckle sheaves on slopes or inclines that change the direction of the rope 90° or more shall have diameters as specified in article 15.
17. All ropes shall be inspected daily.
18. All ropes shall be thoroughly lubricated.
19. The lubricant shall consist of oils or greases that will penetrate between the wires and the strands. The rope shall not be coated with any lubricant that hardens on the outside, as this cracks with bending over sheaves and drums and when exposed to moisture allows the moisture to penetrate to the center and cause internal corrosion.
20. Head sheaves must be in perfect alignment with the slope or incline.
21. All sheaves must run true and be kept in perfect condition.
22. All sheaves shall have grooves that support the rope for one-third of the rope diameter.
23. All metal surfaces on obstructions in contact with the rope must be eliminated.
24. On inclines and slopes the moving rope must be kept from contact with the rails and other metal unless this be impossible, when roller equipment must be installed to the best possible advantage.

SIGNALS.

As elsewhere stated, it would be desirable to have uniform signals all over the country, and the committee carefully considered the question. After making a study and comparison of the codes of signals now in use in the several States, it was found that such radical differences exist that it would be impossible to coordinate them. The accompanying table presents clearly the hopeless discrepancies existing. Consequently the committee confines its recommendations to the few basic signals mentioned. Even then there are differences in practice. For example, in Michigan and in Minnesota it is not customary to use the same signal to stop and to hoist. The committee, however, does not see any great objection against the practice of signaling one bell for starting and one bell for stopping, as such signals prevail in nearly all the States, and as the hoisting engineer is always cognizant of whether the hoist is at a standstill or in motion. The dangers urged against using one bell to hoist are that the signaling system may give out after the first bell of a more complicated signal has been given, or that some falling object may strike the signal wire and give one bell when none was intended. Cases are known where these things have happened with resulting accidents. On the other hand, at the Keating mine in Montana, as noted in Chapter XI of this report, the accidental ringing of one bell saved the lives of two men in a blasting accident.

The most commonly given signal in the mine is the hoisting signal. It is therefore logical to make the signal the quickest and simplest possible. Especially where fast hoisting is necessary to maintain the capacity of the shaft it is important not to waste time

in signaling. The stopping signal must also obviously be as readily given as possible and one bell is almost a necessity. The slight danger of confusion or of accident from other sources does not seem to outweigh the advantages of speed and simplicity and of familiar practice in most sections of the country.

In the case of two signals, practice is in accord practically everywhere in this country, namely, one bell to stop and two bells to lower. Entire unanimity is not found even in the western States as to the blasting signal when sinking. The committee has prescribed four bells as being simpler than the other combinations used and would urge the States in which three-two-one and two-two-one are prescribed to bring their codes into conformity in this respect.

The nine-bell signal, to be used for indicating an accident such as a flood or a fire which endangers the whole working force, is one found in the codes of some States, and one which should be in all. In the report of the Royal Commission which investigated the North Mount Lyell disaster, was included a recommendation for some such general alarm. Its value can not be too much insisted upon. By flashing it on the mine lighting circuit as well as on the signal system the working force can be apprised of danger in a fraction of the time required when dependence is placed on messengers and by its use many wholesale fatalities would be avoided.

Table of the more important signals prescribed by law or in common use in the principal metal-mining States and districts.

State.	Signal pre- scribed by—	1 bell.	2 bells.	3 bells.	4 bells.	5 bells.	6 bells.	7 bells.	8 bells.	9 bells.	Other signals of importance.
Arizona.....	State code.....	Hoist - stop- release shaft conveyance.	Lower.....	Men on.....	Steam on (or off).	Blasting.....	Air on (or off).	Danger.....			
California.....	do.....	Hoist—stop.....	do.....	do.....	Start (or stop) pump.	Send down tools.	Send down timbers.	Foreman wanted— Accident— move vertical orders only.			2-2-1 Blasting.
Colorado.....	do.....	do.....	do.....	do.....							3-2-1 Do.
Idaho.....	do.....	do.....	do.....	do.....	Blasting.....					Danger.	
Michigan: Dickinson County. Goshute County.	In common use.	Stop.....	do.....	Hoist do.....	Lower slowly. Lower men.		Hoist slowly. Hoist men.				{ 1-2 1-3 Lower men. Hoist men.
Iron County.....	(Recommended by commit- tee of mine managers.)	do.....	do.....	do.....	Lower slowly.	Hoist slowly.	(Hoist to shaft) collar.				{ a 3-4 a 8-6 Lower men. Hoist men. Hoist rock.
Keweenaw County.	In common use.		do.....	do.....		Hoist men.	Men on.				
Marquette County.	Used by lead- ing company.	Stop.....	do.....	do.....	Lower men.	Hoist men.	Blasting.....	Steam on (or off).	Air on (or off).	Danger.	10 Fire.
Minnesota: Crow Wing County.	In common use.	do.....	do.....	Hoist ore or empty cage.	Lower men on cage. Lower skip slowly. Lower slowly.	Hoist rock.	Hoist cage with men. Hoist skip slowly. Hoist slowly.	Start compress- sor.	Mo re air.	St o p c o m - pressor.	
St. Louis County.	do.....	do.....	do.....	Hoist.....	Lower slowly.	Hoist slowly to shaft collar.					
Missouri: Joplin district.	do.....	Hoist men— stop.	do.....	Call con- veyance for men.	Pull steel.....						
Montana.....	State code.....	Hoist—stop.....	Lower men.	Hoist men.	Blasting.....	Steam on.	Steam off.	Air on.	Air off.	Danger.	
Nevada.....	do.....	do.....	Lower.	Men on.	do.....					do.	

^a When repeating system is not used.

CHAPTER VI.

DIGEST OF STATE METAL-MINE INSPECTION LAWS.

By C. E. DUTTON.

The following digest of State mine-inspection laws has been made so as to show the technical provisions relating to the operation of mines in the existing laws and to serve as a basis of comparison with the draft of the committee.

The various sections dealing with the reporting of accidents have been omitted for the reason that although every State having an inspection law requires that accidents be reported, the details of such requirements are so varied that nothing was to be gained by printing them when it was known in advance that such sections differ from similar provisions in the proposed code of the committee.

All provisions relating to penalties also have been omitted, because the punishment for violation of specific provisions varies in each of the different States, while the important feature was the matter or thing prohibited. Likewise the sections relating to the hours of labor, the employment of women and children, the fixing of the liability of the owner or operator of mines in case of accident or injury to employees, and the abolition of the fellow-servant doctrine have been left out of the compilation. Similarly the sections dealing with the reports to be made by the inspector, and by the operators to the inspector, have been omitted because they consist largely of detailed enumerations of the contents of such reports. The elaborate enumeration of the specific duties of the inspector with reference to the examination of mines and the machinery connected therewith has been left out as being a matter of detail of only local interest.

The term "operator" has been uniformly used as designating the owner, lessee, manager, superintendent, or other person in charge of the operation of the mine. The phrases used by the various legislatures in order sufficiently to identify the responsible person are necessarily long and cumbersome, so that the term mentioned has herein been used in lieu of all such phrases.

The original arrangement of the various laws by sections has been retained and the section numbers have been inserted so as to facilitate references to the statutes themselves, with the exception that some of the laws have been rearranged, so as to bring together provisions relating to the same subject matter. The original language has been retained so far as possible although materially briefed.

Only the laws of the States in which metal mining is of paramount importance are given here, the laws of States such as Kansas, Oklahoma, and Tennessee, where coal mining is of chief importance, being excluded. Some regulations in force in the zinc district of Wisconsin were drawn up after these digests were prepared and are therefore not noted here.

The law of Colorado has been adopted as a model and references thereto are made when similar provisions are found in the laws of any of the other States.

It will be noticed that in many cases the substance and even the wording of the provisions have been taken from previous drafts of the code published herewith, a fact that the committee considers as a bit of evidence that its efforts have been appreciated. It is to be hoped that the revised and expanded code will be immediately and generally adopted.

ARIZONA.^a

SECTION 1. APPLICATION OF ACT.

The act applies to all mines in the State.

SECTIONS 2, 3, 4, 5. INSPECTOR.

Elected for two years; must be 30 years of age; have resided in the State two years prior to election; have been practically engaged in mining in the State, and have had at least seven years experience in underground mining. He is prohibited from holding office while an employee, director, or officer of any mining, milling, or smelting company. Salary, \$3,000 per annum, and an allowance of \$1,400 for clerk hire and office expenses.

SECTIONS 6, 7. DEPUTY INSPECTORS.

The inspector is authorized to appoint three deputies to hold office during his term, with same qualifications as the inspector. Salary, \$1,800 per annum, and \$1,400 for traveling expenses.

SECTION 8. REPORTS.

The inspector and deputies are prohibited from making any report upon any mine or prospect, save an official report to a superior, and from making public any knowledge or information obtained in the exercise of their duties, under penalty of dismissal.

SECTION 10. DUTIES OF INSPECTOR.

Mines employing upward of 50 men shall be inspected once every three months; every other working mine employing more than 6 men, at least once a year. (The section prescribes in detail the matters to be investigated, substantially the same as in the committee's present draft.) Operators are required to render the necessary assistance to enable the examination to be made.

SECTION 11. DANGEROUS MINES.

If the inspector shall find that a mine is in a dangerous condition, or has failed to comply with the provisions of the act, he shall serve written notice upon the operator,

^a Session Laws, 1912, chap. 33, p. 87. The act is modeled on revised draft previously published by the committee.

stating in what particular the mine is dangerous, or not in compliance with the act, and specifying the changes to be made and the time in which to make them. A certified copy of the notice is made prima facie evidence of the negligence of the operator in the event of loss of life or injuries sustained in consequence of the dangerous condition. If the changes are not made within the time specified, the inspector shall order work to cease and not permit employees to enter except to remedy the defects complained of.

SECTION 12. COMPLAINT.

The inspector shall examine a mine upon receipt of complaint in writing signed by one or more persons employed therein, setting forth that the mine, or any part thereof, is dangerous to health or life and is being operated contrary to law. Names of the complainants must be kept secret in the absence of permission to disclose them.

SECTION 15. RECORD OF INSPECTION.

The inspector shall enter in a book, to be kept at the mine, all dangerous defects observed in the condition of the mine, machinery, and appliances, but nothing contained in or omitted from such entry shall limit the duty of the operator. Such book shall be open at all reasonable times to the examination of the inspector, the operator, and the miners.

SECTION 17. FIRST-AID REQUIREMENTS.

The operator of a mine employing 10 or more men shall keep at the mine entrance, or at such other place as the inspector shall designate, a stretcher and a woolen and a waterproof blanket, in good condition. Where more than 100 persons are employed, two or more stretchers with woolen and waterproof blankets shall be kept. A supply of first-aid remedies shall be kept at all mines. Where 300 or more men are employed, a first-aid corps of employees shall be organized and the services of a competent surgeon and physician shall be procured to instruct the members not less than once a month in the handling and treatment of injured persons.

SECTION 18. MINE MAP.

When ordered by the inspector, the operator of a mine employing upwards of 10 men underground shall make an accurate map of the mine workings, showing all excavations and all parts of the mine worked out or abandoned, and shall bring it up to date at least once in each six months. All underground workings shall be surveyed and mapped before allowed to become inaccessible. Such maps shall be open to the examination of the inspector at all times.

SECTION 19. EXPLOSIVES.

Explosives shall be stored in a separate magazine placed far enough from the working shaft, tunnel, or incline to insure the same remaining intact in case of explosion, and shall not be stored in underground workings where men are employed.

Explosives in excess of the amount required for 24 hours' work must be kept in such surface magazines. The temporary supply shall not be kept at any place underground where its accidental discharge might cut off the escape of miners. A suitable device for thawing explosives shall be provided and no explosives shall be thawed except in such device. Oils or other combustible substances or blasting caps shall not be kept or stored with explosives. High explosives shall be marked with date of manufacture and shall not be stored or used after 12 months from date of manufacture. The use of iron or steel tamping bars is prohibited.

Dealers in explosives are required to keep an accurate and complete record of all transactions, such record to be open at all times to the examination of the inspector or any peace officer.

Warning must be given before firing charges, and misfires must be reported to the mine foreman or shift boss. Where shots are fired by electricity the place must be carefully examined before men are permitted to work therein. The finding of loose wires must be promptly reported, and work must cease until the wires have been traced to their terminals.

SECTION 20. FIRE PROTECTION.

Same as section 4287, Colorado law.

SECTION 21. TWO EXITS TO SURFACE.

Every operator who shall have sunk a vertical shaft or incline to a greater depth than 100 feet and drifted on the vein a distance of 200 feet or more and commenced to stope shall provide a separate escapement shaft, raise, or opening, or underground communication with some other contiguous mine. Where the contiguous mine belongs to a different owner, the right to use the outlet shall be obtained and kept in force.

Work shall be commenced on such escapement shaft or opening as soon as stoping begins, and the same shall be connected with the lowest workings, and shall be of sufficient size to afford easy passageway. If a raise or shaft, it shall be provided with substantial ladders from the deepest workings to the surface. Signboards showing the direction to be taken must be placed at each departure from a continuous course.

SECTION 22. HOISTING MACHINERY.

No person under 18 years of age, or addicted to the use of intoxicating liquors, shall be employed as a hoisting engineer. All hoisting machinery, except in prospect shafts not exceeding 300 feet in depth, shall be equipped with an indicator placed within clear view and hearing of the engineer, which shall be in addition to marks on the rope, cable, or drum. It shall be unlawful to hoist or lower men at a speed greater than 800 feet per minute.

Hoisting machinery must be inspected once every 24 hours by a competent person appointed by the superintendent. Wire ropes or cables shall be used for hoisting purposes in shafts or winzes over 200 feet in depth. All hoisting ropes or cables shall be of approved quality and manufacture.

Headframes shall be constructed so as to provide 25 feet in the clear above the landing stage, where men are hoisted at a speed of over 250 feet per minute, and 25 men or more are employed.

GENERAL HOISTING PROVISIONS.

Shafts less than 300 feet in depth shall be provided with a platform equipped with safety catches for employees to ride upon, where crossheads but no safety cages are used. It shall be unlawful to hoist or lower men in shafts over 300 feet deep unless an iron-bonneted cage with safety catches be used, with gates at least 5 feet in height. This shall not apply to shafts in process of sinking. Cages must have overhead handhold. A cage or skip for hoisting men must be provided with a safety catch of sufficient strength to hold the cage, in case the cable should break. The inspector shall see that cages and skips are equipped in compliance herewith, and that safety catches are kept oiled and in good working order.

Where hoisting is done with bucket, shafts more than 200 feet in depth must be provided with suitable guides and crosshead. If the crosshead is not secured to the hoisting rope, a stopper approved by the inspector must be fastened to the hoisting rope at a suitable point above the rim of the bucket.

The inspector shall determine the number of persons permitted to ride upon the cage, skip, or bucket. Riding upon cage, skip, or bucket loaded with rock or ore is prohibited.

Tools, timber, or other material projecting above the top of the bucket or skip shall be securely fastened, and all tools, timber, or other material loaded erectly upon the cage shall be securely lashed.

No person shall ride upon a cage, skip, or bucket loaded with tools, timber, powder, etc., except to assist in passing same through the shaft.

A cage, skip, or bucket shall not be lowered directly to the bottom of the shaft where men are working, but shall be stopped at least 15 feet above bottom until signal to lower farther has been given. This shall not apply to shafts less than 50 feet in depth. Persons engaged in deepening a shaft in which regular hoisting is being carried on from an upper level shall be protected by suitable covering from falling material, leaving a sufficient opening for passage of the bucket.

A bulkhead shall be provided where two or more crews are working one above another in shafts, winzes, or raises.

Shafts or winzes shall have a bulkhead over men working in the bottom thereof, and shall be cleaned down below such bulkhead after each blasting.

Windlasses and whims shall be provided with a suitable plug or other reliable device to prevent running back of the bucket or conveyance. An approved form of safety hook or shackle hook shall be used with a bucket in hoisting.

A release signal of one bell shall be given the hoisting engineer to release the cage, skip, or bucket after same has been stopped at any station.

Where men are hoisted by mechanical means a hoistman shall be kept on duty at all times when men are underground.

SECTION 23. TWO OUTLETS TO THE SURFACE.

Every mine shall have at least two outlets to the surface, except as hereinbefore provided, which must not be nearer to one another than 30 feet, and must not lead to the same house on the surface.

If in different mines, the respective owners shall be responsible for the part of the outlet in their own mine being kept in repair, any accident jeopardizing the safety of an outlet shall be reported immediately to the operator. If either of the outlets is situated in an abandoned mine, the operator of the working mine shall be responsible for the proper maintenance of such outlet.

No structure shall be erected over the outlet of a mine except the headframe and the hatch or door necessary for hoisting therefrom, and to protect men working at the top from inclement weather. The construction of a small house of noninflammable material may be permitted by the inspector for this purpose. The storage of inflammable materials therein, or within 30 feet thereof, or in any existing house covering shaft, adit, etc., is forbidden.

An adit covered by a building shall be provided with a fireproof door near the mouth, closeable from outside the building.

A shaft, winze, raise, or incline, sloping more than 40 degrees from the horizontal, and more than 40 feet deep, used as a manway, shall be provided with a ladderway. Ladders or footways shall be provided to connect floors of sets in stopes and other places requiring communication. Shafts shall have at least one ladderway or footway from the lowest workings to the surface, in addition to any mechanical means of egress.

Permanent ladderways shall be firmly fastened and kept in good repair. Provision regarding construction of ladderways same as section 4290, Colorado law.

Ladders shall be provided within such distance of bottom of shafts being sunk as will secure them from damage by blasting. Portable ladders shall extend therefrom to the bottom of the shaft.

A station or level shall have a passageway around the working shaft. Sumps shall be securely planked over. A gate or guardrail must be provided at each shaft station. The top of the shaft shall be protected by a gate, guardrail, or chain. Winzes or raises shall be offset from the drift.

Winzes now opening on any drift or tunnel traveled by men shall be covered with a grizzly or by doors. An opening of an offset winze shall be protected by a fence or guardrail of 3 to 4 feet in height above the level of the drift.

Any existing winze, sump, or other opening in the floor of a drift or stope must be kept covered by a substantial hatch or planking, or be provided with a guardrail.

SECTION 24. VENTILATION.

An adequate amount of pure air shall be made to circulate into all working places in quantities sufficient to maintain same in a fit state for working therein. An adequate spraying system shall be installed to settle dusts or gases. The total quantity of carbon dioxide shall not exceed 0.25 per cent by volume, except that after explosives have been fired a higher percentage shall be permissible for a reasonable time. Respirators shall be provided when needed. Waste timber underground shall be removed as soon as practicable.

SECTION 25. LIGHTS.

Stationary lights shall be provided at all shaft stations during time they are in actual use; also at stations in levels where mechanical hoisting or haulage is used; also at night at all working places on the surface; candles shall not be left burning when the person using same departs from his work for the day.

SECTION 26. PROTECTION AGAINST THE INRUSH OF WATER.

When advancing toward a mine working suspected to be filled with water, a bore hole shall be kept at least 20 feet in advance of the breast of the drive; also laterally from the course of the drive. Such working places shall not exceed 6 feet in width, and such additional precautions shall be taken as the inspector deems necessary.

No raise shall approach within 10 feet of a winze or stope containing a dangerous accumulation of water, unless the same be first unwatered.

Where there is danger of sudden inrush of water, such additional raises, drifts, or workings shall be constructed as will insure the escape of the workmen. All sumps and places for the storage of water shall be constructed so as to prevent leakage and insure the safety of men working below same.

It shall be unlawful to impound water except by means of a dam or wall approved by the inspector.

SECTION 28. INTOXICATING LIQUORS.

Intoxicating liquors shall not be taken into a mine. No intoxicated person shall be permitted to enter or remain therein.

SECTION 29. VISITORS.

Same as section 4301, Colorado law.

SECTION 30. WASHROOM.

Every mine employing 25 or more men shall maintain a suitably equipped and heated washroom and change room contiguous to the mine.

SECTION 31. PROHIBITED PRACTICES.

No person shall knowingly injure or destroy any water gage, barometer, air course, brattice, or other equipment or machinery, nor without authority disturb any airway or part of the hoisting engine, neglect to close the door of the mine, disobey any order given pursuant to law, or do any willful act endangering life or the security of the mine or machinery connected therewith.

SECTION 32. DANGER SIGNALS.

The superintendent shall place notices at the entrance of dangerous working places or abandoned workings. No unauthorized person shall remove or go beyond same.

SECTION 33. FIRE HELMETS.

Operators employing 25 or more men underground shall keep at least two fire-fighting helmets in condition to be used, and provide training in the use of same. Tests of the helmets shall be made monthly by actual use.

SECTION 34. SIGNAL APPARATUS.

Shaft or compartment more than 50 feet deep used for hoisting shall be provided with efficient means of interchanging signals between the top and the lowest level and all intermediate levels.

Where a station tender is employed, no other person shall ring the signal bell except in case of danger or when the main shaft is being sunk.

SECTION 35. TROLLEY WIRES.

Electric trolley wires shall be at least 6½ feet above the floor, save in mines newly equipped, where they shall be at least 7 feet above the floor.

SECTIONS 36, 37. SIGNAL CODE.

The following signal code shall be used: 1 bell, hoist muck, stop, release conveyance; 2 bells, lower; 3—1 bells, hoist men; 3—2 bells, lower men (if bells are rung slowly, move slowly); 5 bells, ready to blast or shoot (the engineer must acknowledge by raising the bucket or cage a few feet and lowering it again; the engineer must accept no other signal and must be prepared to hoist away from blast when 1-bell signal is given); 4 bells, steam on or off; 6 bells, air on or off; 7 bells, danger signal (followed by station signal calling cage to that station; this signal takes precedence over all others except an accepted blasting signal).

Number of bells.	Station No.	Number of bells.	Station No.	Number of bells.	Station No.
1—2.....	Collar of shaft	2—4.....	7	5—1.....	14
1—3.....	1	2—5.....	8	5—2.....	15
1—4.....	2	4—1.....	9	5—3.....	16
1—5.....	3	4—2.....	10	5—4.....	17
2—1.....	4	4—3.....	11	5—5.....	18
2—2.....	5	4—4.....	12	And so on.	
2—3.....	6	4—5.....	13		

Station signals must be given before hoisting or lowering signals. Engineer shall not move cage, skip, or bucket unless he understands signal. Copies of the code shall be posted on the gallows frame, at each station, and before the engineer. Special signals may be used if easily distinguishable.

CALIFORNIA.^a

SECTIONS 1, 2, 3, 4.^b MINE EXITS.

It shall be unlawful for the operators of a quartz mine employing 12 men to sink any perpendicular shaft to a greater depth than 200 feet without providing a second

^a The safety provisions of the workman's compensation, insurance, and safety act (Session Laws, 1913, chap. 176, secs. 51-72) are broadly worded so as to include mine workings, whether underground or surface, and the Industrial Accident Commission is empowered to make and enforce safety rules and regulations and to order the reporting of accidents. Rules and regulations governing mining operations have not as yet been promulgated.

^b Hittell's Code and Statutes of California, vol. 2, secs. 15638-15640, p. 1552 (Session Laws, 1871-72, p. 413).

exit for such mine by shaft or tunnel to connect with the main shaft at a depth of not less than 100 feet from the surface. It shall be the duty of each operator to provide such mode of egress. Failure so to provide shall subject the operator to liability for damages resulting to any person injured in the mine. In case of loss of life, right of action survives to the heirs or relatives of the deceased.

SIGNAL CODE.^a

The following signal code is prescribed: 1 bell, hoist; 1 bell, stop (if in motion); 2 bells, lower; 3 bells, man to be hoisted (run slow); 4 bells, start pump, if not running, or stop pump, if running; 1—3 bells, start or stop air compressor; 5 bells, send down tools; 6 bells, send down timbers; 7 bells, foreman wanted; 2—1—1 bells, done hoisting until called; 2—2 bells, done hoisting for the day; 2—2—2 bells, change buckets from ore to water, or vice versa; 2—2—1 bells, ready to shoot in the shaft; engineer must raise bucket 2 feet and lower again; miners must then give signal "man to be hoisted," spit fuse, get into bucket, and give signal to hoist.

RULES GOVERNING SIGNALS.

Make strokes on bells at regular intervals. The bar (—) must take same time as one stroke of bell. If timber, tools, etc., are wanted to stop at any level, give number of level first before giving signal for timber, etc. Time between signals to be double bars (— —).

Getting off or on bucket or cage while in motion is forbidden. When men are to be hoisted, give signal for men; man must get on bucket or cage, then give signal to hoist; bell cord must be within reach of man on bucket or cage at stations.

Timbers, tools, etc., projecting above bucket must be securely lashed to cable; miners must make certain such material will ride without catching on rocks or timbers.

Printed copy of signals to be posted at each level and in engine-room.

Violation of rules is ground for dismissal; operator not responsible for accidents to men disobeying rules and signals.

An operator failing to carry out the provisions of the act is responsible for all damages incurred by persons working in the mine during time of such failure.

SECTIONS 1, 2, 3, 4.^b FENCING ABANDONED SHAFTS.

Abandoned shafts, pits, or excavations dangerous to persons or live stock shall be securely covered or fenced and so maintained by the owner of the land, or the person in charge of same. Such shafts, pits, or excavations on unoccupied public lands may be so covered or fenced by the board of county supervisors, and it shall be the duty of such board to keep the same fenced or covered at the expense of the county, whenever proof is submitted that same are dangerous or unsafe.

SECTION 1.^c EXPLOSIVES.

Defines what shall be embraced by the term "explosives," as employed in the act (includes all forms of explosive substances).

SECTION 2. STORAGE OF EXPLOSIVES.

The keeping or storing of explosives except in tight wooden or fiber containers, and except during period of transportation, is prohibited. Pending delivery to assignee, explosives must be kept in a magazine, as hereinafter provided. It is forbidden to permit grains or particles of explosives to remain on the outside of, or about, such containers.

^a Session Laws, 1893, chap. 74, p. 82.

^b Session Laws, 1903, chap. 232, p. 283.

^c Session Laws, 1911 chap. 213, p. 391. Sections relating to transportation of explosives by common carriers, etc., omitted.

SECTION 3. MAGAZINES.

Magazines in which explosives may be kept are of two classes:

Magazines of the first class shall comprise those containing upward of 50 pounds of explosives, and shall be constructed of brick, wood covered with iron, or other fireproof material; shall be bullet-proof; and shall be kept locked except when explosives are being stored or removed. Openings for ventilation must be screened so as to prevent the entrance of sparks or fire. A sign marked "MAGAZINE—EXPLOSIVES—DANGEROUS," in letters not less than 6 inches high, shall be posted on each side of the magazine. Matches, fire, or lighting devices of any kind shall not be permitted therein. Packages of explosives shall not be opened in the magazine, nor opened packages kept therein; blasting caps, detonators, or electric fuses shall be kept in a separate magazine situated 100 feet from the explosives magazine, which latter must be situated at least 100 feet from any other structure.

Magazines of the second class shall comprise those containing less than 50 pounds of explosives, and shall consist of wooden boxes covered with sheet iron, and shall be kept securely locked. A sign marked "MAGAZINE—EXPLOSIVES—DANGEROUS," shall be posted on the magazine. Storage of explosives in a tunnel is permitted when no persons are employed therein, provided such tunnel shall have fireproof doors, which shall be kept locked, except when explosives are being stored or removed; the door of such tunnel magazine shall be marked with the words "MAGAZINE—EXPLOSIVES—DANGEROUS."

SECTION 10. RECORD OF EXPLOSIVES.

Prescribes in detail the manner in which entries must be made of sale, delivery, or other disposition of explosive substances.

SECTION 11. STORAGE OF EXPLOSIVES UNDERGROUND.

Explosives in excess of the amount sufficient for one day's operation shall not be taken into any mine.

SECTIONS 1, 2.^a TELEPHONE SYSTEM.

In mines operating at a depth greater than 500 feet, a telephone system must be established with stations at each working level below 500 feet connecting with a station on the surface.

COLORADO.^b

SECTIONS 4259, 4261. STATE BUREAU OF MINES. COMMISSIONER OF MINES.

State bureau of mines established. Bureau shall be in charge of a commissioner, to be appointed by the governor for a term of four years. Qualifications: Seven years' practical mining experience and practical knowledge of metallurgy and geology.

SECTION 4262. MINING DISTRICTS. INSPECTORS.

The State shall be divided into four metalliferous districts, the boundaries being fixed by the statute. The commissioner, with the consent of the governor, shall appoint an inspector for each district. The inspector shall be a citizen of the United States, with seven years' practical experience in mining in Colorado; term of office, two years.

^a Session laws, 1913, chap. 368, p. 782.

^b Revised Statutes, 1908, chap. 91 (Mills's Annotated Statutes, 1912, chap. 107, divs. 11 and 13, secs. 4931-4960 and 4985-5002), as amended by Session Laws, 1911, chap. 91, pp. 123, et seq.

SECTION 4273. SALARIES.

The salary of the commissioner shall be \$3,000 per annum, with an allowance of \$1,000 for traveling expenses; that of the inspectors shall be \$1,800 per annum, with \$1,200 traveling allowance.

SECTION 4264. DEPUTY INSPECTORS.

The commissioner is authorized to appoint deputy inspectors in the several districts for special investigations.

SECTION 4267. INSPECTION OF MINES—RESTRICTIONS ON INSPECTORS.

The commissioner and inspectors are prohibited from acting for any mining or other corporation during tenure of office and from making reports as to mineral properties to aid in the sale or conveyance thereof, and are required to give their whole time to the duties of their office. The commissioner, upon receipt of information concerning conditions dangerous to health or safety of workmen, is required to have an examination made. Operators are given the right to appeal to the commissioner from report of the inspector. Fatal or nonfatal accidents must be investigated.

SECTION 4269. INSPECTION.

Operators are required to admit the inspector and to render necessary assistance in the making of investigations.

SECTION 4270. NOTICE OF DEFECTS.

The inspector shall give notice to the operator when any matter, thing, or practice is found to be dangerous or defective and shall order same to be remedied. The operator shall comply with said order within 30 days and notify the commissioner of such compliance. The time for compliance may be extended to a period not exceeding 90 days when necessary. The operator is permitted to enjoin the inspector from enforcing such order when he deems same unauthorized or unreasonable, the court being empowered to vacate or modify the order as deemed proper.

SECTION 4271. PENALTY FOR DIVULGING RESULTS OF INSPECTION.

The commissioner and inspectors are prohibited from revealing, otherwise than in official reports, information obtained as a result of inspections.

SECTION 4272. ENFORCEMENT OF INSPECTION ORDERS.

If an operator fails to comply with the provisions of this act or with any order of the inspector thereunder, a court of competent jurisdiction at the instance of the inspector or commissioner may enjoin the further working of the mine or plant until such provision or order is complied with.

SECTION 4277. STORAGE OF OILS.

Oils and other inflammable material shall be stored in a building erected for that purpose at a safe distance from the mine buildings and from powder magazines, and shall be removed only in quantities sufficient to meet the requirements of one day.

SECTION 4278. CAGER.

A cager shall be employed to load and unload the cage or skip and to give all signals to the engineer in mines hoisting material from two or more levels and employing steam or other hoisting power.

SECTION 4280. EXPLOSIVES.

Explosives shall be stored in a separate magazine placed far enough from a working shaft, tunnel, or incline to insure the same remaining intact in a case of explosion. All explosives in excess of the amount required for the work of one shift shall be kept in such magazines. Powder or other explosives shall not be stored in underground workings where men are employed. Suitable devices for thawing powder shall be provided. Oils or other combustible substances shall not be kept in the same magazine with explosives.

SECTION 4282. TAMPING BAR.

The use of a steel or iron tamping bar is forbidden.

SECTION 4283. REMOVAL OF OLD TIMBERS.

All old timber removed shall be taken from the mine as soon as practicable and shall not be piled up or permitted to decay underground.

SECTION 4284. HOISTING ENGINEER.

No person addicted to the use of intoxicating liquors or under 18 years of age shall be employed as a hoisting engineer.

SECTION 4285. HOISTING APPARATUS.

All hoisting machinery employing steam, electricity, air, or hydraulic power for the hoisting or lowering of employees or material shall be equipped with an indicator placed near to and in clear view or hearing of the engineer.

SECTION 4286. MINE SIGNALS.

A uniform code of mine signals shall be established by the commissioner and shall be adopted in all mines using hoisting machinery. Such code shall be posted in clear and legible form in the engine room, at the collar of the shaft, and at each level or station. Shafts equipped with cages shall be supplied wherever possible with a system of electric signals from cage and stations to engineer.

SECTION 4287. FIRE PROTECTION.

A mine having only one exit which is covered by a building containing the mechanical plant, furnace room, and blacksmith shop, shall have fire protection—water, if possible; otherwise, chemical extinguishers or hand grenades.

SECTION 4288. RIDING WITH TOOLS PROHIBITED.

All persons shall be prohibited from riding upon any skip, cage, or bucket loaded with tools, timber, powder, or other material, except for the purpose of assisting in passing same through shaft or incline, and then only upon special signal.

SECTION 4289. FALSE SIGNALS.

All persons giving or causing to be given false signals or riding upon any cage, bucket, or skip upon signals designating that no employees are aboard, shall be deemed guilty of a misdemeanor.

SECTION 4290. LADDERWAYS.

Shafts more than 200 feet in depth equipped with hoisting machinery shall be divided into at least two compartments, one of which shall be set aside for a ladderway.

In vertical shafts, landings shall be constructed not more than 20 feet apart and closely covered, except for an opening large enough to permit the passage of a man. Ladders shall be inclined at the most convenient angle, firmly fastened, and kept in good repair. In inclined shafts, landings shall be put in as above, but straight ladders shall be used on the incline of the shaft. Ladders shall be provided in upraises and winzes, but where winzes connecting levels are used only for ventilation and exit, only one such winze on each level need be so equipped.

SECTION 4291. EMERGENCY EXITS.

A shaft equipped with buildings and machinery with only the working shaft for exit shall be divided into two compartments, one of which shall be used as a ladderway, as hereinbefore provided. Said ladderway shall be bulkheaded at least 25 feet below the collar of the shaft, below which a drift shall be run to the surface, if the location of the shaft is upon the side of the hill; but if the shaft is located upon a level, the drift shall be run to a safe distance without the walls of the building and then raised to the surface. The ladderway and landings shall be kept in good repair and shall afford easy mode of escape in event of fire.

SECTION 4292. TUNNELS.

Tunnels or adit levels shall connect with the surface at a safe distance from the mouth of same and be provided with safe and suitable ladders.

SECTION 4293. CHAIN LADDERS.

Employees engaged in sinking a shaft or incline shall be provided with a chain or other ladder arranged to insure safe means of exit.

SECTION 4294. SHAFT COLLARS, SAFETY CLUTCHES, SHAFT DOORS.

Collars of shafts shall be protected so that persons or foreign bodies can not fall into the shafts. Safety clutches shall be used in all shafts equipped with cages; in shafts equipped with buckets shaft doors must be used, so as to prevent material falling into the shafts when dumping is being done.

SECTION 4295. GUARDRAILS.

All stations or levels shall have a passageway around working shafts when practicable. A guardrail shall be provided at all shaft stations, so as to prevent persons from walking, falling, or pushing a car or other conveyance into the shafts. Winzes and mill holes shall be covered and protected with guardrails to prevent persons from falling into same.

SECTION 4296. PILLARS.

A pillar shall be left standing on each side of the shaft of sufficient dimensions to protect and secure same. Stopping shall not be permitted to approach within such proximity to the shaft as to render same insecure, until the mine is to be abandoned and the pillar drawn.

SECTIONS 4297, 4298. ABANDONED SHAFTS TO BE COVERED.

All abandoned shafts, pits, or excavations dangerous to life shall be securely covered or fenced.

SECTION 4300. MISREPRESENTATION OF FACTS.

Willful misrepresentation or withholding of facts or information from an inspector with regard to a mine or safety conditions therein is a misdemeanor punishable by fine.

SECTION 4301. VISITORS.

Visitors shall not be allowed underground unless accompanied by the owner, official, or employee deputized to accompany them.

SECTION 4302. NUMBER OF MEN PERMITTED TO RIDE IN BUCKET.

Notice of the maximum number of men permitted to ride on cage, bucket, or skip at one time shall be posted at the collar of the shaft and at each level.

SECTION 4304. ENFORCEMENT OF ACT.

The commissioner and inspectors are empowered to make examination of the condition of any mine, mill, or metalliferous plant and the machinery and devices therein, and to determine whether the provisions of the act are complied with. They are authorized to appear at all coroners' inquests and to call and examine witnesses.

SECTION 4306. JURISDICTION.

Justices of the peace are given jurisdiction in prosecutions for violations of the act.

IDAHO.^a

SECTION 199. INSPECTOR.

The inspector shall be elected biennially. Salary, \$2,400 per annum, and not to exceed \$1,800 for traveling expenses, and not to exceed \$1,200 for clerk hire and office expenses.

SECTION 200. DISQUALIFICATION.

Disqualification for holding office of inspector substantially the same as the in first part of section 4265, Colorado law.

SECTION 201. DUTIES OF INSPECTOR.

Prescribes in detail the duties of the inspector, examinations to be made, and data to be collected.

SECTION 202. EXAMINATION OF MINES.

Empowers the inspector to examine all mines, and requires the operator to render necessary assistance. If the mine is found to be in an unsafe condition, the inspector must serve written notice upon the operator, specifying changes to be made. In case of loss of life or serious injury, because of neglect or refusal to comply with the notice, a certified copy thereof is made prima facie evidence of culpable negligence.

SECTION 204. COMPLAINTS TO INSPECTOR.

Substantially the same as section 12, Arizona law, except that complaint is required to be signed by three or more persons.

SECTION 206. DEPUTY INSPECTOR.

The inspector, with the approval of the governor, may appoint such deputy inspectors as are deemed necessary; salary, \$5 per diem, when actually employed.

SECTION 208. DUTIES OF DEPUTIES.

Prescribes in detail the duties of deputy inspectors.

SECTIONS 1276-1277. INCLOSURE OF RESERVOIRS AND DUMPS.

The operator of a quartz mill must inclose reservoirs or dumps containing material injurious to stock.

SECTIONS 1555, 1556, 1557. EXPLOSIVES.

The sale or use of explosives shall be unlawful, unless the name of the manufacturer, date of manufacture, and percentage of nitroglycerin or other high explosive is stamped or printed on the box, package, or wrapper. It is unlawful to have two or more dates on any such box or package or to reuse any such box, package, or wrapper.

SECTION 27.^a STORAGE OF EXPLOSIVES.

It is unlawful to store more explosives underground than are required for 24 hours use, or to store or thaw powder in a dwelling or in a building in which men are employed, other than a building for the storing or thawing of same. Powder shall be stored only in a properly designed building or underground excavation, used exclusively for that purpose and conspicuously marked as such, which shall be situated not less than 200 feet from any building or working place, unless an impregnable natural object intervenes.

Thawers using fire, candles, lanterns, or lights of any kind are prohibited in mines employing more than 15 men.

SECTION 28. TAMPING BARS.

The use of steel, iron, or other metal tamping bars is prohibited.

SECTION 29. STORAGE OF OILS.

Substantially the same as section 4227, Colorado law.

OPERATION AND EQUIPMENT OF MINES.^a

The following provisions apply to all mines in the State:

SECTIONS 2, 3. FIRE PROTECTION.

First part of section same as section 4287, Colorado law.

A working adit, or crosscut tunnel entrance, with wooden buildings at the portal shall be provided with a fire door, not less than 50 feet from the portal, such door to be self-closing when released; it shall be held open by a rope terminating outside of the building at the mouth; if electric haulage is used, two doors hung from the sides and closing tightly may be used. Such tunnel shall be provided with a raise and ladderway to the surface, inside of the fire door, when such tunnel connects with an exit from underground workings.

SECTION 4. TWO EXITS TO SURFACE.

Mines employing 15 or more men underground shall be provided with more than one exit where the vein has been driven on and stoping commenced, work thereon to be commenced immediately, if none exists.

SECTION 5. LADDERWAY.

Shafts 100 feet or more in depth shall have two or more compartments, one of which shall be used as a manway and fitted with substantial ladderway having platforms at intervals not to exceed 20 feet; ladders shall be inclined at convenient angles, and shall be in lengths not to exceed 20 feet.

^a Session Laws, 1909, p. 266.

SECTION 6. EMERGENCY EXIT.

Substantially the same as section 4291, Colorado law.

SECTION 7. BUILDINGS AT MAIN ENTRANCE.

The construction of new buildings over, or at, the entrance to a mine, is prohibited. Frame buildings shall be placed not less than 25 feet from the entrance, except in high, snowy countries, where a shed is permitted between the buildings and the main entrance, of such construction that it can be rapidly destroyed in case of fire.

SECTION 8. PROTECTION OF SHAFT COLLAR AND MINE OPENINGS.

The collar of a shaft shall be protected so that persons and foreign objects can not fall in; a winze, chute, timber slide, or mill hole shall be protected by a plank or guard rail when not in use for a considerable length of time; abandoned or unused surface shafts or raises to the surface shall be securely fenced off or covered.

SECTION 9. CAGE OR BUCKET.

It shall be unlawful to operate a vertical or inclined shaft more than 250 feet in depth without equipping same with cage, skip, or bucket fitted with safety clutches. Where bucket is used, same must be attached to fixed crosshead by two chains or cables; loose crossheads are prohibited. A cage or skip, where used, shall be provided with bonnet to be made of boiler sheet iron three-sixteenths of an inch thick, and covering the top of the cage so as to afford protection from falling objects. The cage shall also be provided with safety clutches. Where skip and cage are used in the same compartment, the bonnet may be dispensed with, if the skip is placed above the cage. This shall not apply to skips, cages, or buckets used solely for hoisting or lowering materials.

SECTIONS 10, 11. GALLOWS FRAMES.

Gallows frames shall be equipped with automatic chairs, so placed as to catch the cage or skip and prevent its falling in case of overwinding. Such frames shall be not less than 40 feet in height between the collar of the shaft and the sheave wheel if the shaft has reached 250 feet in depth and stopping has commenced.

SECTION 12. INDICATORS.

Hoists used in the handling of men shall be equipped with indicators placed in clear view of the engineer, positively geared to the shaft or drum, and so adjusted as to show the exact location of bucket, cage, or skip.

SECTION 13. USE OF ELECTRICITY.

Electric power cables underground shall be thoroughly insulated. Trolley wires underground must be protected by inverted U-shaped guards placed along the trolley wires opposite any hand-loading chutes.

SECTION 14. SHAFT SIGNAL.

Shafts equipped with bucket, cage, or skip, operated by a hoist, shall be supplied with pull bell; also with an electric bell and flash-light signal, where practicable.

SECTIONS 15, 16. SIGNAL CODE.

The following signal code is prescribed:

One bell, hoist; 1 bell, stop (if in motion); 2 bells, lower; 3 bells, hoist men, run slowly; 4 bells, blasting signal (engineer must answer by raising bucket or cage a few feet and letting it back slowly), then 1 bell, hoist men away from blast; 9 bells, danger signal, to be followed by the station call where the danger exists.

No person, other than the cager, shall ring the signal bell, except in case of necessity and only after giving 7 bells to notify the engineer that some person other than the cager is ringing.

The following station signals are also prescribed:

Number of bells.	Station No.	Number of bells.	Station No.	Number of bells.	Station No.
2—1.....	1	2—5.....	5	3—4.....	9
2—2.....	2	3—1.....	6	3—5.....	10
2—3.....	3	3—2.....	7	4—1.....	11
2—4.....	4	3—3.....	8	And so on.	

A copy of the entire code shall be posted on the gallows frame, and a copy of the bell signals shall be posted before the hoist engineer and at each station.

SECTIONS 17, 18, 19, 20. CAGER.

A mine employing more than 15 men, and equipped with cages or skips for hoisting from two or more levels, shall employ a cager to load and unload the cage or skip and to give signals to the hoisting engineer. It shall be unlawful for any cager or other person to ride upon the cage or skip, except upon signal for the handling of men. Private or short signals shall not be allowed when men are to be hoisted or lowered. It shall be unlawful for anyone except the cager to ring the hoist bells without first giving a stop signal, indicating that some one other than the cager is ringing the bell. It shall be unlawful for men to travel on a loaded cage or skip, other than the cager or those assisting him in loading or unloading material.

SECTION 21. RIDING ON THE BAIL.

It shall be unlawful for any person to ride upon the bail or cable of a hoisting bucket, cage, or skip.

SECTIONS 22, 23, 24, 25. HOISTING ENGINEER.

It shall be unlawful for any person under 21 years of age, or addicted to the use of intoxicating liquors, to be employed as a hoisting engineer. It shall be unlawful to raise or lower a bucket, cage, or skip, except upon bell signals, or to hoist or lower men at a greater speed than 600 feet per minute, or to hoist or lower men after the cage has remained idle several hours, until one round trip has been made with the empty cage. When a shaft is equipped with chairs at the several levels, the hoisting engineer must slow up in passing stations when men are on the cage or skip. It shall be unlawful for the hoisting engineer while on duty to converse with anyone except those assisting him, and then only when necessary.

SECTION 26. INTOXICATED PERSONS.

No person under the influence of liquor shall be permitted underground.

MICHIGAN.^a

SECTIONS 1, 3, 4, 5. INSPECTOR.

An inspector shall be elected for a term of two years in any county where working iron or copper mines are situated. Qualifications: Must have had at least 10 years' actual experience in mining, timbering, and general underground work, or hold the degree of mining engineer, or an equivalent degree, and have practiced his profession for at least 2 years.

^a Public Acts, 1911, public act 163, p. 265, as amended by Public Acts, 1913, public act 158, p. 275 (Howell's Annotated Michigan Statutes, 2d ed., vol. 2, chap. 65, p. 1753).

SECTION 6. DEPUTY INSPECTOR.

The inspector may appoint not exceeding three deputies, their duties to be prescribed by him.

SECTIONS 7, 11. SALARY OF INSPECTOR AND DEPUTIES.

The board of county supervisors shall fix the compensation of the inspector and deputies, that of the inspector to be not less than \$5 per day, and that of the deputies not less than \$3.50 per day when actually employed, mileage in addition to be allowed at the rate of 4 cents per mile for actual distance traveled.

SECTION 8. DUTIES OF INSPECTOR.

Prescribes in detail the examinations to be made by the inspector. The inspector is required to see that shafts and open pits are furnished with safeguards so as to prevent the falling in of persons or foreign matter; he is also required to take the steps prescribed for providing fences or railings about all shafts and openings in idle or abandoned mines.

SECTION 9. LIABILITY OF OPERATOR.

The operator shall be liable for accidents causing injury or death to employees when such employees are permitted to continue work in any place condemned by the inspector, save for the purpose of making it safe.

SECTION 10. ASSISTANCE TO INSPECTOR IN MAKING EXAMINATIONS.

It is the duty of the operator to furnish the inspector with maps, drawings, and plans of the mine, together with contemplated changes in the manner of working same, and to provide all necessary assistance in the making of examination.

SECTION 12. COMPLAINT TO INSPECTOR.

The inspector shall make examination of a mine upon receipt of notice, oral or written, that his services are needed. Any such notice shall be forever privileged in any court. Making public the name of the person giving such notice is a misdemeanor.

SECTIONS 1, 2, 3.^a POWER AND MACHINE DRILLS.

The operator of any iron or copper mine shall arrange the work underground so that no employee shall be permitted to operate any power or machine drill at a distance of more than 150 feet in the same drift, stope, opening, or working from where another person is regularly employed, under penalty of a fine.

MINNESOTA.^b

SECTIONS 1, 2, 6, 13. INSPECTORS.

The board of commissioners of any county where at least five mines are in operation is authorized to appoint an inspector for a term of three years, and to fix his compensation and traveling expenses. The inspector must be 25 years of age, a citizen of the State, and resident of the county, and have been employed in the mines of the State for at least six years, or have had two years' practical experience in iron mining as a mining engineer, and at least one year's such experience in the State. He is prohibited from being interested directly or indirectly in any mine. His salary shall

^a Public Acts, 1913, public act 220, p. 436.

^b General Laws, 1905, chap. 166, p. 208, as amended by General Laws, 1911, chap. 133, p. 168 (General Statutes of Minnesota, 1913, secs. 3924-3936)

not exceed \$2,000 per annum, and he shall be allowed not to exceed \$600 traveling expenses. He is subject to removal from office for neglect of duty, malfeasance, incompetency, drunkenness, or other good cause.

SECTION 3. DUTIES OF INSPECTORS.

The section prescribes in detail the duties of the inspector with reference to the examination of mines. He is required to order the men to quit work if a place is found to be dangerous, and to serve written notice on the operator specifying necessary changes to be made. The provisions regarding the fencing of shafts or open workings of any abandoned or idle mine are substantially the same as section 8 of the Michigan law.

SECTION 4. EMPLOYER'S LIABILITY.

Operators requiring employees to work in any place wherein they have been forbidden to work by the inspector, save for the purpose of making the same safe, are made liable for all accidents causing injury or death to any such employee by reason of noncompliance with the inspector's orders.

SECTION 5. INSPECTION OF MINES AND MACHINERY.

Specifies the powers of the inspector with reference to the examination of mines, and requires the operator to render necessary assistance in making such examination, under penalty.

SECTION 7. DEMAND FOR INSPECTION.

Whenever 20 or more employees in any mine, or the operator thereof, shall notify the inspector in writing that his services are needed, he is required to make an immediate inspection, and to see that the provisions of the act are complied with.

SECTION 9. TIMBER.

The operator shall keep on hand a sufficient supply of timber and lagging for the purpose of rendering mine workings safe.

SECTION 10. REMOVAL OF FENCES, ETC.

The opening, removal, or disturbance of any fence, guard, or rail without closing or replacing same in front of a shaft, test pit, chute, or excavation, whereby accident, injury, or damage results is made a misdemeanor.

MISSOURI.^a

SECTION 8464. STATE BUREAU OF MINES ESTABLISHED.

The governor shall appoint a chief mine inspector for a term of four years, at an annual salary of \$2,000. The chief inspector shall appoint, with the approval of the governor, four lead, zinc, and other mine inspectors who shall have had five years' practical experience in lead and zinc mining, who shall receive an annual salary of \$1,800, but who shall not be interested in any mine. The chief inspector shall also appoint a secretary of said bureau, who shall be a competent draftsman, and receive an annual salary of \$1,800. Actual and necessary expenses shall be allowed the inspectors.

SECTIONS 8465, 8466. REPORT.

Requires inspector to see that precautions are taken to promote health and safety of employees, and that act is complied with; also prescribes the contents of annual report to be submitted to the governor, and of reports to be submitted to the inspector by the operator.

^a Revised Statutes, 1909, re-enacted by Laws, 1909, pp. 317, 318, 319, 320, and Laws, 1917, p. 409.

SECTIONS 8439, 8440. LUNCH HOUR.

Operators shall allow one hour in which the employees of the mine are permitted to come to the surface to eat their noon-day meal, and shall run the hoisting apparatus for such purpose.

SECTIONS 8441, 8442. MINE MAPS.

Every operator employing 10 or more men, at the discretion of the inspector, shall make an accurate mine map showing workings, veins, general inclinations of strata, natural deflections in workings, and boundary lines of the mines, and shall submit annually a further map showing progress of the mine workings. Where the operator fails to furnish such map, the inspector is authorized to have same made at the operator's expense.

SECTION 8455. BORE HOLES.

Operators must keep bore holes 20 feet in advance of the face of each working place, and, if necessary, on both sides when driving toward an abandoned mine, or part thereof, suspected to contain inflammable gases, or to be filled with water.

SECTION 8456. SIGNALING APPARATUS. SAFETY CAGE.

The operator of a mine operated by a shaft shall provide suitable means of signaling between bottom and top, and safe means of hoisting or lowering persons in a cage covered with boiler iron. Such cage shall be furnished with guides and with a sufficient brake on every drum to prevent accident in case of breaking of machinery. Every cage shall be furnished with a spring catch to prevent accident in case of breaking of the cable, or injury to the machinery. Props or rails shall not be lowered in the cage while men are being hoisted or lowered.

SECTION 8457. HOISTING ENGINES. HOISTING PROVISIONS.

The operator of a mine operated by shaft or slope shall not place any but an experienced, competent, and sober person, not under 18 years of age, in charge of a hoisting engine. Such operator shall not operate the hoisting machinery unless he is in such proximity to the engine and drum as will enable him continuously to have control of both. No person shall ride upon a loaded cage or wagon in any shaft or slope, and not more than 12 persons shall ride on a cage or car at any one time, the exact number to be fixed by the inspector. Men shall not be lowered or hoisted at a greater speed than 500 feet per minute.

SECTION 8467. INSPECTION.

It shall be lawful for the inspector to enter and inspect at any time any mine and the machinery belonging thereto, but not to hinder workings of such mine. The operator is required to furnish all necessary facilities for inspection. If the inspector shall find the mine being worked contrary to law, or to be in a condition dangerous or detrimental to life or health by reason of defects in timbering, mining, ventilation, or sanitation, he shall, through the county attorney, after giving two days' notice, proceed by injunction against the operator, who shall have the right to appear in court; if sufficient cause appear, the court shall prohibit the further working of the mine until the same is made safe and the act complied with.

SECTION 8467-A. COMPLAINT.

Whenever the inspector shall receive a written complaint signed by one or more employees of a mine, stating that such mine is being operated contrary to law, or is

dangerous to life or health, and setting forth the violation of law or the nature of the danger, and whether notice thereof has been given to the person in charge of the mine, he shall examine such mine as soon as possible. The names of complainants shall not be divulged except when necessary in the administration of justice in the courts.

If the inspector shall find conditions dangerous to life or health he shall serve written notice upon the operator and take steps to compel compliance with the law. Complaints shall be forwarded to the State bureau of mines for filing.

SECTION 8469. VENTILATION.

The inspector is authorized to inspect underground workings as often as deemed proper and ascertain conditions with respect to the health of employees. If the inspector shall find that health is impaired by reason of insufficient circulation of air, he shall notify the operator in writing, specifying the underground excavations found to be unhealthful, and direct the operator within 15 days after receipt of notice to commence to drill a sufficient number of air holes, or to sink a shaft to connect with such excavations, or make a drift connection with contiguous mines at a point or points to be agreed to by the inspector. The inspector may order all work in the excavations affected to cease until the work shall have been completed.

SECTION 8471. EMPLOYER'S LIABILITY.

For injury to persons or property occasioned by violations or noncompliance with the act a right of action shall accrue to the party injured for direct damage sustained; in case of loss of life the right of action accrues to the widow, children, or other dependent persons. Recovery is limited to \$10,000.

SECTION 8472. PROHIBITED PRACTICES.

Substantially the same as section 31 of Arizona law, save that carrying of open lights into places worked by light of safety lamps is prohibited, and violation is made a misdemeanor

SECTION 8473. TIMBERS.

The operator shall keep a sufficient supply of timber to be used as props, so that workmen may secure the workings from caving. It shall be the duty of the operator to send down such props when required.

SECTIONS 1, 2, 3, 4, 5.^a EXPLOSIVES.

No operator shall permit any blasting powder or high explosive containing nitroglycerin to be stored in a mine in excess of the requirements thereof during the succeeding 24 hours. Such temporary supply shall not be kept where its accidental discharge would cut off the escape of miners working therein. All blasting powder or high explosive in excess of such supply shall be stored in a ventilated magazine not less than 300 feet distant from any shaft, habitation, public highway, or railway, or from the boundary line of any mining property, except that where the location of any mining property makes it impossible to comply herewith the inspector may grant written permission to place the magazine in some other place on the property if it is in his opinion not dangerous to the safety of employees in the mine.

Detonators or explosive caps shall not be kept in the same magazine with blasting powder or high explosives.

No operator shall permit blasting powder or other high explosive to be prepared for firing or blasting in any magazine in which such powder or explosive is stored.

^a Laws, 1911, p. 321; based on previous draft of committee.

INSPECTOR TO POST STATEMENTS. CONDITION OF MINES. NUMBER OF MEN TO RIDE
IN CAGE. SPEED.^a

The inspector shall post in a conspicuous place at the top of a mine inspected by him a statement of the conditions therein, showing what is necessary for better protection of the lives and health of the employees. A copy of such notice shall be recorded in the record book at the mine. He shall also post notice at the landing, stating the number of men permitted to ride on cage car at one time, and at what rate of speed men may be hoisted or lowered.

MONTANA.^b

SECTION 1710. APPLICATION.

The provisions of the article apply to mines employing five or more men.

SECTION 1711. INSPECTOR.^c

The inspector is appointed by the governor for a term of four years. Salary, \$2,500 per annum. Qualifications: Must be 30 years of age, a resident of the State one year, and theoretically and practically acquainted with mining in all its branches. He is prohibited from holding the position while an employee or officer of any mining company.

SECTION 1712. DEPUTY INSPECTOR.^c

The deputy inspector is appointed by the governor for four years. The same qualifications as for inspector are required. Salary, \$2,400 per annum.

SECTIONS 1713, 1716. DUTIES OF INSPECTOR.

Prescribes in detail the duties of the inspector with reference to the examination of mines. Requires him to serve notice in writing upon operator of unsafe conditions found in the mine and requires same to be remedied. He is authorized to forbid the operation of a mine when necessary, save for the purpose of making necessary changes to render the mine safe

SECTIONS 1714, 1715. COMPLAINT.

The inspector is required to examine a mine upon receipt of written complaint, signed by one or more persons, setting forth that the mine is dangerous. If the mine is found to be dangerous he is required to notify the operator in writing and require necessary changes to be made. Copy of such notice is made prima facie evidence of negligence in any action at law for loss of life or injury sustained by any employee in consequence of failure to obey such notice. The operator is also made subject to criminal prosecution if he neglects or refuses to comply with the notice.

SECTION 1722. SAFETY CAGE.

It is unlawful to sink or work through a vertical shaft at greater depth than 200 feet where a cage is used unless an iron-bonneted safety cage is provided. The safety apparatus must be securely fastened to the cage and be of sufficient strength to hold same loaded at any depth. The bonnet shall be of good quality boiler sheet iron, at least three-sixteenth inch thick, and shall cover the cage so as to afford the greatest protection from falling objects.

^a Laws, 1913, p. 410.

^b Revised Political Code, 1907, pt. 3, title 7, chap. 2, as amended by Session Laws, 1909, chap. 71, p. 94, and Session Laws, 1911, chap. 65, p. 128.

^c The inspection department is now a part of the Department of Labor and Industry (see Session Laws, 1913, chap. 55, p. 106), no other change being made in the laws relating to same.

SECTIONS 1724, 1725. SIGNAL CODE.

Same as that of Idaho law, except that 5 bells call for steam on, 6 bells steam off, 7 bells air on, 8 bells, air off, 3—2—2 bells, send down drills, and 3—2—3 bells, send down picks.

Station signals.—Same as prescribed in Idaho law.

Rules governing signals.—Except in case of danger, or when the main shaft is being sunk, no one save the station tender shall ring any bell. The engineer must slow up when passing stations, when men are on the cage.

Where electric bells are used in connection with other bells, if cage is wanted, ring station signal; station tender will answer 1 bell; reply, 1 bell to go up, 2 bells to go down; if station is full of ore, and station tender is wanted, ring station signal and do not answer back; if 2—1—2 bells are rung, repeat signal, as the engineer or station tender does not understand; in case of danger or accident, ring station signal; station tender will reply 1 bell; then ring 9 bells.

Copy of the code must be posted on the gallows frames and before the engineer.

SECTIONS 1734, 1735. HOISTING ENGINEER.

It is unlawful for any person to handle or operate a hoisting engine at any mine for more than eight hours in each day, except in case of sickness or emergency. The provision applies only to plants in continuous operation or operated more than 16 hours in each 24.

SECTION 8635.^a MINE SHAFT IN CITY.

A substantial cover or tight fence must be placed around any shaft, drift, or cut, within the limits of any city, town, or village, or within 1 mile thereof, or within 300 feet of any public highway.

SECTION 8536. SAFETY CAGE.

Is substantially the same as section 1722, save that it applies only to shaft 300 feet or more in depth and that casing of sheet iron or steel is required to be not less than one-eighth thick and not less than 5 feet high, with doors of same material to be closed when hoisting or lowering men. Where cage is used for shaft sinking only, doors need not be provided. The inspector is required to see that section is complied with.

SECTION 8537. STOPING NEAR SHAFT.

It is unlawful to stope within 25 feet of any vertical or inclined shaft when other work is being carried on below.

SECTIONS 8538, 8540. SPEED OF RUNNING CAGE.

It is unlawful to run any cage with men upon same at a greater speed than 800 feet per minute. The hoisting engineer is made personally liable if he violates the order of the operator in running the cage at a greater rate of speed.

SECTIONS 8541, 8542. ESCAPEMENT SHAFTS.

Substantially the same as section 21, Arizona law, save that the latter applies only to quartz mines employing more than nine men, and does not apply to mines not extracting ores by stoping, nor to mines in which the working shaft is not covered by nonfireproof building or has not such a building within 30 feet of the shaft or opening, nor to mines where the hoisting shaft is covered by a fireproof building.

^a This and the following sections are taken from part 1, title 10, Revised Penal Code, 1907, penalties being provided for violation.

SECTION 8545. SALE OF EXPLOSIVES.

Requires accurate and complete record to be kept of disposition of all explosives, the records to be subject to examination by the inspector.

SECTION 8546. STORAGE OF EXPLOSIVES IN MINES.

No greater quantity than 3,000 pounds of explosive substances shall be stored in any mine, and no explosive whatever shall be stored where its accidental explosion would cut off the escape of miners working therein.

SECTION 1.^a VENTILATION.

Operators of quartz mines when working at a greater depth than 300 feet are required to provide a suitable and practicable method for ventilation, either by separate shaft or other mine working, so as to provide for the delivery of air to all portions of the mine being worked, and to furnish reasonable means of carrying away noxious fumes, gases, or smoke.

SECTION 2. TOILET FACILITIES.

Operators of mines employing 30 or more men shall provide suitable toilet arrangements for employees, consisting of properly constructed toilet cars or receptacles, which shall be sent to the surface each day for cleansing. Where toilet apparatus is not provided, employees shall be allowed to go to the surface or other suitable sanitary place. Underground stables shall be cleaned daily and waste taken to surface.

SECTION 3. PROTECTION OF UNDERGROUND OPENINGS.

Underground shaft, manway, winze, or opening for ventilation or for the removal of ore or waste shall be protected by a guardrail or by a grizzly made of substantial timbers or metal bars. Shaft stations shall be protected by guardrails. Vertical manways shall be provided with landings not more than 30 feet apart in addition to ladders. All manways or air courses used as escapement ways must be kept free from obstruction.

NEVADA.^b

SECTION 4209. APPLICATION.

The act shall apply to all mines except those worked exclusively by owners or lessees, and in which no men are employed for wages.

SECTIONS 4198, 4199, 4200, 4210, 4239. INSPECTOR.

The inspector is elected every four years; salary, \$3,600 per annum, and not exceeding \$1,800 per annum for traveling expenses and \$1,200 for office expenses. Qualifications: Practically the same as fixed by sections 4262 and 4267, Colorado law.

SECTION 4206. DEPUTY INSPECTOR.

The deputy is appointed by the inspector at a salary not to exceed \$200 per month and traveling expenses.

SECTION 4201. DUTIES OF INSPECTOR.

Requires the inspector to visit each mining county at least once a year, and to examine into the condition of such mines as in his judgment require examination, to collect statistical data, etc.

^a Session Laws, 1911, chap. 72, p. 135.

^b Revised Laws, Nevada, 1912, as amended by Statutes, 1913. Follows committee's previously published code in many respects.

SECTION 4202. DANGEROUS MINES.

Prescribes the powers of the inspector with reference to the examination of mines, and requires the operator to render necessary assistance in making the examination. Otherwise, substantially the same as section 11, Arizona law.

SECTION 4203. RECORDS.

Prescribes in detail the records to be kept in the office of the inspector, and requires operators to submit annually certain specified information.

SECTION 4204. COMPLAINT.

Substantially the same as section 12, Arizona law.

SECTION 4205. NONCOMPLIANCE WITH NOTICE.

Requires inspector to start proceedings through the attorney general or the county attorney looking to the criminal prosecution of an operator failing to comply with the contents of the notice specified in the preceding section.

SECTION 4211. EXPLOSIVES.

Substantially the same as sections 1 and 2 of the Missouri law (Laws, 1911).

SECTION 4212. TAMPING BARS.

Operators shall furnish wooden tamping bars to be used in charging holes. The use of a steel or metal tamping bar is made a misdemeanor.

SECTION 4213. DEAD TIMBER.

Same as section 4283, Colorado law.

SECTION 4214. INDICATOR.

Same as section 4285, Colorado law, save that indicator is required only to be in plain view of the engineer.

SECTION 4215. RIDING ON LOADED CAGE.

Same as section 4288, Colorado law.

SECTION 4216. LADDER COMPARTMENT.

All shafts shall be equipped with ladders. Shafts more than 200 feet deep, inclined more than 45 per cent from the horizontal, and equipped with hoisting machinery shall be divided into at least two compartments, one of which shall be set aside for a ladderway. Ladders shall be sufficiently strong for the purpose. Landings shall be not more than 30 feet apart, and closely covered, except an opening large enough to permit the passage of a man. Landings shall be constructed in manway at working levels. Provision regarding ladders in upraises and winzes same as in section 4290, Colorado law.

SECTION 4217. EMERGENCY EXITS.

Is similar to section 4291 of Colorado law, with the exception that it applies only to shafts 200 or more feet in depth, and permits the use of a trapdoor in lieu of a bulkhead, such door to be closable by a rope from the outside. The drift, if any, must be run at least 30 feet beyond the walls of the building.

SECTION 4218. SIGNBOARDS.

Whenever the exit is not in a direct or continuous course, signboards showing the direction to be taken must be placed at each departure from a continuous course.

SECTION 4219. GASOLINE.

The use of gasoline underground is forbidden, except that gas engines of not more than 8 horsepower may be operated not more than 100 feet below the surface if the engine exhausts into a pipe extending to the surface, or not more than 250 feet below the surface if the exhaust is attached to a pipe through which air is drawn by suction fan, or otherwise, to the surface. The engines and method of installation shall be subject to the approval of the inspector.

SECTION 4220. CHAIN LADDERS.

Same as section 4293, Colorado law.

SECTION 4221. GUARDRAILS.

Same as section 4295, Colorado law, save that passageway around working shaft is not required.

SECTION 4222. CAGES.

Cages in shafts over 350 feet deep shall be provided with sheet-iron or steel casing not less than one-eighth inch thick, or with netting of wire not less than one-eighth inch in diameter, and with doors of same material as side casing, either hung on hinges or working in slides. Doors shall extend at least 4 feet above the bottom of cage, and must be closed when men are being hoisted or lowered, except when timbermen are riding to attend to timbers being lowered or hoisted. Where the cage is used for sinking only, doors need not be provided. Cages must have overhead bars so arranged as to give every man an easy and secure handhold.

SECTION 6799. CAGE.

It shall be unlawful for an operator to work through a vertical shaft more than 350 feet in depth, unless the same is provided with an iron-bonneted safety cage, safety crosshead, or safety skip for hoisting and lowering employees. Safety apparatus of sufficient strength to hold the cage loaded at any depth shall be securely fastened to the cage. Where safety crossheads are used for other than sinking purposes the same shall be equipped with gates, as required for cages.

Where a skip is used for other than sinking purposes a platform for men to stand on when being hoisted or lowered shall be placed in such skip not less than 4 feet from the top, and an overhead handhold provided.

In shafts of less depth where crossheads are used but no safety cage, safety crosshead, or safety skip, platforms for employees to ride upon shall be placed above such crossheads. Violation is made a misdemeanor.

SECTION 4223. PILLARS.

Same as section 4296, Colorado law.

SECTION 4224. BUILDING OVER SHAFT.

Same as in section 23, Arizona law (paragraph 3).

SECTION 4225. BUILDINGS AT MOUTH OF TUNNEL.

Similar to section 23 of Arizona law (paragraph 4), except that a raise, inside the fire door, to the surface is required.

SECTIONS 4226, 4227. HOISTING ROPES.

It shall be unlawful to use any rope or cable for hoisting or lowering men by other than human or animal power, unless same is composed of iron or steel wires, provided that such wires may be laid around a hemp center.

The factor of safety of all ropes or cables shall not be less than five, to be calculated by dividing the breaking strength of the rope as given in the manufacturer's published tables, by the sum of the maximum load to be hoisted, plus the total weight of the rope when fully let out, plus 10 per cent of such values.

It shall be unlawful to use any such rope or cable when the number of breaks in any running foot exceed 10 per cent of the total number of wires composing same, or when the wires on the crown of the strands are worn down to less than one-half their original diameter, or when it shows marked signs of corrosion.

SECTION 4228. BOILERS.

Boilers for generating steam shall be kept in good order, and the operator shall have them inspected by a qualified person once in six months, and oftener if the inspector shall deem it necessary. The result of the examination shall be certified in writing to the inspector within 30 days thereafter.

SECTIONS 4229, 4233, 4234, 4235. HOISTING PROVISIONS.

No hoisting shall be done in any shaft compartment when repairs are being made therein, except such as is necessary to make repairs.

When men are in a mine equipped with hoisting machinery, an engineer at all times shall be kept on duty to answer signals. It shall be unlawful for any person to ride upon the bail or cable of a hoisting bucket, cage, or skip.

Provision regarding number of men to ride upon cage, etc., is same as that in section 4302, Colorado law.

Riding upon an overloaded cage, etc., is made a misdemeanor.

SECTION 4236. SIGNAL CODE.

The signal code is practically the same as that of Idaho (see sec. 15, Idaho law). The station signals are the same, save that the signal 3—1 is omitted, which makes the signal for six stations 3—2, and so on.

The rules governing signals are the same as for Montana.

SECTION 4230. WAGES.

Wages shall not be paid on premises used for the sale of intoxicating liquors.

SECTION 4231. VENTILATION.

The operator of every mine shall maintain a sufficient amount of ventilation for men and animals employed therein, and shall cause an adequate amount of fresh air to circulate through and into all shafts, winzes, levels, and working places.

SECTION 4237. SMOKE HELMETS.

Every mine employing 40 or more men underground shall keep on hand in good working condition at least two smoke helmets of design to be approved by the inspector. An additional helmet shall be provided for each additional 50 men employed.

SECTION 6797. SHAFTING.

It shall be unlawful for an operator to construct any shaft or shafting with collars, sleeves, or pulleys more than 2 feet in diameter attached to such shaft by set screws projecting above the hub of such collars. Where such set screws are used the heads

shall be countersunk below the surface of such collar, sleeve, or pulley. Violation is made a misdemeanor.

SECTION 1.^a PROTECTION OF SHAFTS.

Operators shall erect a substantial fence or other safeguard around an excavation, shaft, etc., so as to guard against persons or animals falling therein, while in process of working, or when abandoned.

SECTIONS 2, 3, 4, 6. VIOLATIONS.

Prescribe penalties for violation of the foregoing provision, and provide for the performance of the work, either at the expense of the operator or at the expense of the county.

SECTIONS 3898, 3899, 3900, 3901, 3902, 3903, 3904. STATIONARY AND HOISTING ENGINEER.

The board of county commissioners shall have power to regulate the operation of stationary engines, steam apparatus, or other hoisting machinery used for hoisting or lowering men or material from a shaft or mine, and to prepare, issue, and revoke licenses to operate same. The operation without a license of any such engine or machinery is made a misdemeanor.

SECTIONS 1, 2, 3, 4.^b PASSAGEWAYS BETWEEN CONTIGUOUS MINES.

Operator shall not place any bulkhead or door in any passageway connecting contiguous mines, or refuse to allow the use of such outlet in case of accident, but a door that can be quickly opened or readily broken may be maintained.

Where a door has been erected the necessary tools for opening same shall be kept in a conspicuous place near-by. Violation is made a misdemeanor.

SECTIONS 1, 2, 3, 4, 5.^c MACHINE DRILLS.

Operator shall not cause holes to be drilled by machinery in any slope or raise in ground that causes dust, unless a water jet or other means equally efficient to prevent escape of dust be provided. Where jets or sprays are used, water free from pollution shall be furnished. Where machinery is so equipped it shall be unlawful to drill a hole without using such appliance. Violation is made a misdemeanor.

SECTIONS 1, 2, 3, 4, 5.^d DUST SPRINKLERS.

Every operator shall equip any chute from which dusty ore or rock is taken with a sprinkler or other device to prevent the escape of dust into air during removal, provided that, where in the opinion of the inspector the installation of such device is impracticable, he shall have power to exempt a property. Such device shall be placed so that it can be operated by the workman loading cars from such chute.

Ore houses in which dusty ore or rock is sorted shall be provided with suitable clean water to be used to allay the dust.

Failure to comply is a misdemeanor.

The act shall not apply to mines employing less than 10 men or to chutes baled in the open air.

SECTIONS 1, 2, 3. MINERS MUST SPEAK AND READ ENGLISH.

It shall be unlawful to employ in underground mines, or in the handling of explosives in underground or surface mines any person who can not clearly speak and readily

^a Statutes, 1907, p. 437.

^b Statutes, 1913, chap. 64, p. 53.

^c Statutes, 1913, chap. 125, p. 167.

^d Statutes, 1913, chap. 215, p. 305.

understand the English language, or who can not readily read and understand any sign, notice, etc., printed in the English language. Violation is made a misdemeanor.

NEW YORK.^a

SECTION 119. INDUSTRIAL BOARD—REGULATIONS.

Every necessary precaution shall be taken to insure the safety and health of employees in mines and quarries. The industrial board shall have power to adopt rules and regulations to enforce this notice. The rules and regulations heretofore prescribed by the commissioner of labor shall remain in force until amended or repealed by the industrial board.

SECTION 120. COMMISSIONER OF LABOR.

Charges the commissioner with the enforcement of the act and prescribes in detail the records to be kept and the matters to be examined and inspected; also the contents of the annual report.

SECTION 121. OUTLET OF MINES.

When necessary for the safety of employees, the operator of a mine worked through a vertical or inclined shaft, or horizontal tunnel, shall not employ persons therein unless there are two openings from the subterranean workings to the surface, at least 150 feet apart, connected with each other, and so constructed as to prove a safe means of ingress or egress.

SECTION 122. VENTILATION—TIMBERING.

A ventilating current shall be circulated along the face of working places and through roadways in sufficient quantities to insure the safety of employees, and to remove smoke and noxious gases. The operator shall cause the mine to be properly timbered, and the roof and sides of each working place to be properly secured. No person shall be permitted to work in an unsafe place, except to make it secure.

SECTION 123. STORAGE OF EXPLOSIVES AND INFLAMMABLE MATERIAL.

No powder or oils of any description shall be stored in a mine, or in or around shafts, engines, or boiler houses. All supplies of an inflammable and destructive nature should be stored a safe distance from the mine opening. No person shall ride on any loaded car, cage, or bucket.

SECTION 124. MACHINERY INSPECTION

Boilers should be kept in good order and be inspected once in six months by a competent person approved by the commissioner, the certificate to be filed in the main mine office, and a duplicate in the office of the commissioner. Engines, brakes, cages, buckets, ropes, and chains shall be kept in good order and inspected daily by the superintendent, or a person designated by him. Cars and lifts shall be supplied with safety brakes; lifts, ropes, hoists, and other mechanical devices shall be properly designed and maintained to sustain the weight intended to be placed thereon. Hoist ropes shall have a breaking strength of not less than five times the gross load suspended, including the weight of the rope itself. Every boiler or battery of boilers shall be provided with safety valve and steam and water gages; every boiler house shall be provided with steam gage connected with the boilers; a steam gage shall be attached to the steam pipe in the engine house and so placed that the engineer can readily ascertain the pressure carried.

^a Consolidated Laws, 1903, chap. 31, p. 2976, as amended by Laws, 1913, chap. 145, p. 258.

SECTION 125. EXPLOSIVES.

High explosives other than gunpowder are to be stored, handled, and fired in accordance with the rules prescribed by the commissioner; the use of an iron or steel-pointed tamping bar is prohibited, unless the end is tipped with at least 6 inches of copper or other soft material. No person shall be employed to hoist unless the superintendent is satisfied that he is qualified by experience to perform the work with ordinary safety. When a blast is about to be fired, notice shall be given by the person in charge thereof to all persons who may be in danger.

SECTION 126. ACCIDENTS.

Report of loss of life or serious injury is required to be made within 48 hours to the commissioner. Nothing contained in such report is admissible evidence in any action arising out of any such accident. A record of all such accidents is required to be kept in such form as may be prescribed by the commissioner.

SECTION 127. NOTICE OF DANGEROUS CONDITION.

If a mine is found to be in a dangerous condition, written notice specifying the defects is required to be served upon the operator, who must forthwith remedy same.

SECTION 128. TRAVELING WAY.

A traveling way not less than 5 feet high and 3 feet wide must be cut around the sides of every hoisting shaft, or driven through the solid strata at the bottom thereof, to enable persons to pass around the shaft without crossing through the hoisting compartment.

SECTION 129. NOTICE OF OPENING NEW MINE.

The section requires the operator about to engage in the development of new shaft, incline, etc., to report same to the commissioner.

SECTION 130. NOTICE OF ABANDONMENT.

Operators are required to notify the commissioner of the prompt closing or abandonment of any mine.

SECTION 131. EMPLOYMENT OF WOMEN AND CHILDREN.

No child under 16 years of age is permitted to work in or in connection with any mine. No woman may be employed in any mine.

SECTION 132. HEADHOUSE; WASHROOM.

Every underground working 40 feet in depth shall be equipped with proper headhouse and trapdoors. Every mine, tunnel, or quarry employing over 25 men shall maintain a suitably equipped and heated washroom, which shall be accessible at all times.

SECTION 134. BLASTS.

No blasts shall be exploded by electric current of more than 250 volts.

SECTION 135. ENFORCEMENT OF ARTICLE.

The commissioner may serve written notice on an operator, requiring him to comply with any provision of the article, and shall begin action in the supreme court to enforce compliance therewith. Upon such notice as the court directs, an order may be granted restraining the working of a mine or tunnel during such time as therein specified.

SECTION 136. ADMISSION OF INSPECTOR.

An operator shall admit the commissioner or any authorized representative at any time, for the purpose of making examination, and shall render necessary assistance in the making thereof.

RULES AND REGULATIONS PRESCRIBED UNDER SECTIONS 120 AND 127.

1. *Superintendent.*—The superintendent will see that all provisions of the law and of these rules are enforced, and shall watch all work done by contractors, to see that they comply therewith.

2, 3. *Inspection by operator.*—The superintendent shall designate a competent person who shall each day make inspection of all mining appliances, boilers, engines, magazines, etc., and report defects in writing to the superintendent. Boilers shall be examined daily, and any imperfections reported to the master mechanic or superintendent.

4. *Timbering.*—Timber shall be of mill size and strength, and shall be used freely and wherever there is any chance of danger. Only new and properly seasoned timber shall be used, which shall be carefully inspected before using, and periodically thereafter.

5. *Drilling.*—The use of air instead of steam for drilling in underground workings is advised.

6. *Signals.*—Special attention shall be given to signals, and the keeping of appliances therefor in order. The bell line shall be of ample strength and be kept free and clear from rock and timbers. A shaft of 400 feet or over shall have a speaking tube or telephone from the foot of the shaft to the engine room. A code of signals shall be posted at different parts of the workings, and at the shaft head.

7. *Ladderways.*—Substantially the same as section 4290 Colorado law, save that no depth is specified, and also a handrail is required to be attached to the holder in inclined shafts.

8. *Shaft.*—The shaft head shall be covered and guarded, to prevent persons or foreign objects falling therein. Automatic doors should be used. Manways shall be around, and not across, the shafthead. The timbering of the shaft shall be sounded and examined often. Inside shafts, winzes, and chutes shall be carefully guarded. When shaft sinking is in progress below levels where mining is being carried on, the collars at the lower level shall be covered to prevent objects from falling down, such covering to be of timber not less than 4 inches thick. Where a cage is used a bonnet shall be placed over it.

9, 13. *Hoisting engineers.*—The superintendent shall use extraordinary care to see that engineers are mentally and physically qualified; where persons are lowered or hoisted, engineers shall not be less than 21, otherwise not less than 18 years of age; they shall not delegate the control of the hoisting machinery to any other person, and no one shall interfere with them in the discharge of their duties; the hoisting engineer shall be in constant attendance at his engine whenever workmen are underground; he shall not permit any one to loiter in the engine room; he shall hold no conversation while the engine is in motion, or while his attention should be occupied with signals; he shall understand the signal code, which must be delivered in a clear and unmistakable manner; when he receives a men signal, he shall work his engine with extra care and at a moderate rate of speed; he, or some designated employee, shall keep careful watch over the engine, pumps, ropes, and hoisting apparatus, and report defects.

14, 17. *Hoisting machinery.*—Hoisting machinery shall be kept in a safe condition and inspected every 24 hours by a competent person; the operator or superintendent shall provide a telephone or metal speaking tube from the top to the bottom of every shaft in which persons are raised or lowered; other modes of signaling from top to

bottom must be provided; each cage for hoisting or lowering persons shall be provided with a proper safety catch and a sufficient overhead covering for protection; flanges with a clearance of not less than 4 inches where the whole of the rope is wound on the drum shall be attached to the side of the drum; adequate brakes shall be attached; safety gates shall be placed at all shafts so as to prevent persons from falling in.

The main governing chain attached to the socket of the wire rope shall be of best quality of iron and properly tested. The bridle chain shall be attached to the hoisting rope above the socket from the top crosspiece of the carriage or cage, so that no single chain shall be used for lowering or hoisting persons.

No greater number of persons shall be lowered or hoisted at any one time than may be allowed by the commissioner, notice of such maximum number to be kept posted in a conspicuous place at the top of the shaft.

18. *Dangerous machinery.*—All machinery to which accidents are liable to occur shall be suitably guarded or railed off.

19. *Fire protection.*—Waste, candles, etc., shall be at a safe distance from the boiler house, engine room, and shaft house, and a quantity of water shall be there stored to guard against fire; shafthouses shall have ample fire protection and appliances shall be kept in condition for immediate use. Mining plants using steam should have hose attached to the injector or feed pipe for use in case of fire.

20. *Storage of explosives.*—Explosives shall be stored in a magazine provided for such purpose, located far enough from working shaft, slope, tunnel, boiler house, or engine room so that in case of explosion there would be no danger. Explosives in excess of the requirements for one shaft shall be kept in the magazine, which shall be fireproof and bullet-proof. A suitable place for storing powder shall be provided and kept in condition for use; a hot-water or steam bath device should be used. Explosives and powder shall not be kept in the same room. A suitable place, separate from the mine boilers or engine room, shall be provided for preparing charges; one man shall have full charge of the magazine.

21. *Blasting.*—All blasting shall be done by one man and his helper, to be designated by the superintendent; after blasting no one shall be permitted in that part of the mine until the blaster has made a personal examination and pronounced "all over." In case of misfire no one except the blaster and his helper shall be allowed within that part of the mine within three hours thereafter, until the blaster shall have made a personal examination and pronounced all safe. No person addicted to the use of intoxicants shall use or handle explosives; tamping shall be done with a wooden bar; sufficient warning shall be given when a blast is about to be fired.

SECTIONS 1-8. DYNAMITE.

Dynamite must be stored in a building isolated from other buildings and from traffic. Electric exploders and fuses shall not be stored in the same building with powder, but kept apart until needed for preparing a charge. The greatest care must be used when dynamite is hauled in mine cars or similar vehicles. Neither caps, exploders, fulminators, friction matches, nor any article of like nature shall be loaded in the same car or vehicle with dynamite.

A separate building for thawing shall be fitted with small steam radiator and only exhaust steam be used for heating it; the temperature of the room to be kept at 80° F., the powder to be placed on racks in the part of the room farthest from the radiator; only small quantities shall be thawed; a thawing kettle may be used, consisting of two water-tight bottles, one inside the other, the space between to be filled with water heated to 120° to 130° F., and the kettle to be fitted with a cover. Never place kettle over the fire to heat when more hot water is required; empty and fill again; never thaw powder by placing it in hot water, or by exposing it to the direct action of steam.

Powder must not be placed on or near hot steam pipes, steam boilers, stoves, or any hot metals, nor exposed to radiated heat therefrom; nor roasted, toasted, or baked, or taken near a blacksmith forge; never allow smoking or fire of any description or any loose caps or fuses near it.

RULES FOR EMPLOYEES.

1. No employee shall ride on any loaded skip, car, cage, or bucket, nor walk up or down any slope or shaft while skip, car, cage, or bucket is above.
2. The pit boss shall each day carefully examine and sound hanging wall at working face, and remove loose rock or ore before drilling.
3. Machine runners shall sound hanging wall at working face and remove loose rock or ore before proceeding to drill.
4. No employees shall handle explosives nor do any blasting except the person designated by the superintendent.
5. After a blast no one except blaster shall be allowed inside of mine where same was fired until blaster has made personal examination and pronounced all safe.
6. No iron or steel bars, unless tipped with 6 inches of copper or other soft metal shall be used for tamping explosives.
7. The superintendent or person designated shall daily examine all mining appliances and see that they are in safe condition.
8. In case of a misfire no one shall return to that part of the mine in less than three hours, or until the blaster, after personal examination, shall have pronounced all safe.
9. No person addicted to the use of intoxicants shall have charge of any explosives, boilers, engines, or hoist, nor shall any person under the influence of liquor be allowed in any part of the mine.

OREGON.^a

SECTIONS 2139, 2149. SALE OF LIQUOR.

The sale of intoxicating liquors within one mile of a quartz or placer mine in active operation shall be unlawful.

SECTIONS 5152, 5153 5154, 5155. SIGNAL CODE.

The following signal code is prescribed: 1 bell, hoist; 1 bell, stop; 2 bells, lower; 2—2 bells, calls topman to top of shaft; 3 bells, man to be moved, run slow; 3—1 bells, man to be hoisted, run slow; 3—2 bells, man to be lowered, run slow; 4 bells, move bucket or cage very slow; 4—1 bells, start pump; 4—2 bells, stop pump; 1—3 bells, start air compressor; 2—3 bells, stop air compressor; 5 bells, send down tools; 6 bells, send down timbers; 7 bells, accident; 2—2—2 bells, change bucket from ore to water, or vice versa; 3—2—1 bells, ready to shoot in shaft.

RULES GOVERNING SIGNALS.

Bucket or cage must be raised 6 feet when not in use.

Employees must not get on or off bucket or cage while in motion. Bell cord must be within reach of man on bucket or cage.

Timbers, tools, etc., to be hoisted or lowered, when longer than the depth of bucket or cage, must be securely lashed at upper end to the cable; miners must know they will ride up or down shaft without catching.

Violation of above signals is made ground for discharge.

The operator is not responsible for accidents happening to employees disobeying above rules and signals, which must be signalled by the superintendent or by the person in charge.

^a Lord's Oregon Laws, 1910.

SOUTH DAKOTA.^a**SECTION 146. APPLICATION OF ACT.**

The act shall not apply to mines in which only the owners or lessees thereof are permitted to work.

SECTIONS 136-139, 149-152. INSPECTOR.

The inspector shall be appointed by the governor for a term of two years, by and on the advice and consent of the senate. Qualifications: Shall be a citizen of the United States, a resident of the State, 30 years of age, and practically acquainted with mines and mining and all its branches. Disqualification for office is same as in section 4, Arizona law. Salary, \$1,200 per annum, and not exceeding \$1,000 for traveling and office expenses. Form of oath and seal are prescribed. Allowed 10 cents per mile traveled. Maps, plans, records, etc., are required to be turned over to his successor in office.

SECTIONS 140, 142. DUTIES OF INSPECTOR.

Prescribes in detail the duties of the inspector with reference to examination of mines. The operator is required to render necessary assistance in the making of same, but inspection shall not be at his expense. Inspector shall at least once a year visit each mining county, examine as many mines as practicable, and make necessary recommendations for safety of workmen. If a mine is found to be in an unsafe condition, he shall serve notice upon the operator.

SECTION 141. COMPLAINT.

Same as section 204, Idaho law.

SECTIONS 1, 2.^b LADDERWAYS.

In shafts 50 feet or more in depth containing two or more compartments, ladderways shall be constructed in a compartment separate from that in which the cage or bucket runs. Platforms shall be built every 12 feet with inclined ladders between. Violation shall be a misdemeanor.

SECTIONS 1, 2, 3.^c SIGNAL CODE.

Same as prescribed by Idaho law, except 5 bells is call for steam on; 6 bells, steam off; 7 bells, air on; 8 bells, air off; 3-2-2 bells, send down tools.

STATION SIGNALS.

Same as prescribed by Idaho law.

RULES GOVERNING SIGNALS.

If cage is wanted ring station signal. Station tender will respond in person. If station is full of ore and tender wanted, ring station signal. Copy of code shall be posted on gallows frames, and before engineer.

UTAH.^d**SECTIONS 1538, 1539, 1540. FENCING OF SHAFTS.**

Any person sinking a shaft or well on the public domain shall inclose same with a substantial curb or fence at least 4½ feet high. A mine operator who has caused the

^a Revised Codes, 1903.

^b Session Laws, 1903, chap. 179, p. 210.

^c Session Laws, 1903, chap. 181, p. 211.

^d Compiled Laws, 1907.

surface to cave and form a pit into which persons or animals are likely to fall shall cause same to be filled up or be securely fenced.

SECTION 1540 X. FIRE PROTECTION.

Same as section 4287, Colorado law, except that a hose of sufficient length to reach the farthest point of the plant is required to be attached to the feed pump, ready for immediate use where steam is used.

SECTION 1540 X-1. SAFETY CAGES.

Substantially the same as section 1 of Nevada law (statutes, 1905, p. 199), save that bonnet is required to be made of boiler sheet iron, at least three-sixteenths of an inch in thickness.

SECTION 1540 X-2. STORAGE OF POWDER.

It shall be unlawful for any operator employing more than 10 men at one time to store in any shaft house or covering of an adit, incline, or tunnel more powder or other high explosive than is required for 24 hours' work.

SECTIONS 1540 X-3; 1540 X-4. FIRST-AID SUPPLIES.

Operators of mines employing 10 or more men shall keep readily accessible a properly constructed stretcher, woolen blanket, waterproof blanket, and other specified first-aid supplies for the treatment of persons injured in the mines.

WASHINGTON.^a

SECTION 75. SHAFTS TO BE FENCED.

Substantially the same as Nevada law.

SECTION 89. HOISTING CAGE.

Substantially the same as section 1540 X-1, Utah law.

WYOMING.^b

SECTIONS 3843, 208, 215, 216. INSPECTOR.

The State geologist shall act ex officio as inspector. He shall be appointed by the governor and hold office for a term of six years and receive a salary of \$2,400 per annum. No person having a pecuniary interest in any mining property in the State shall be eligible. The sections set forth in detail his duties with reference to the examination of mines and authorize him to cross-examine witnesses at coroners' inquests.

SECTION 3484. ADMISSION TO MINES.

Substantially the same as section 4269, Colorado law.

SECTION 3485. DANGEROUS MINES.

If the inspector shall find any thing or practice in or about a mine to be dangerous or defective, he shall give notice in writing thereof and order same to be remedied. Upon compliance with such order the operator shall notify the inspector in writing.

SECTION 3486. WILLFUL MISREPRESENTATION OF CONDITIONS.

Substantially the same as section 4300, Colorado law.

^a Pierce & Washington Com., 1902, title 37.

^b Compiled Statutes, 1910.

SECTIONS 2964, 2966. EXPLOSIVES.

Explosives shall not be stored within 1,000 feet of any house or habitation, except with the sanction of the board of county commissioners.

SECTION 2965. POWDER MAGAZINE.

Powder magazines shall be constructed so as to maintain the storage room entirely below the natural surface of the adjacent ground. Storage of powder or explosives in any other room shall be unlawful.

SECTION 2967. SALE OF EXPLOSIVES.

Nitroglycerin or other high explosives shall not be sold after 12 months from date of manufacture, which date must be marked on each stock of powder.

SECTION 2968. STORAGE OF EXPLOSIVES.

Substantially the same as section 4280, Colorado law, save that the provision concerning storage of oils is omitted.

SECTION 2969. STORAGE OF OILS.

Substantially the same as section 4277, Colorado law.

SECTION 2970. TAMPING BAR.

Substantially the same as section 4282, Colorado law.

SECTION 5890. INTOXICATING LIQUORS.

The entry into any mine or metallurgical works of any person under the influence of liquor, or the carrying of intoxicating liquor into same, shall be a misdemeanor.

SECTIONS 3489, 3490. MINE SIGNALS.

The following signal code is prescribed: 1 bell, hoist; 1 bell, stop (if in motion); 2 bells, lower; 3 bells, men on, run slowly; 7 bells, accident, hoist or lower by verbal orders only; 3—2—1 bells, ready to shoot—after receiving signal, engineer shall raise the bucket or cage 2 feet and lower again, remaining at post until final signal is given and executed.

Signals not in conflict with the above may be adopted. The inspector is empowered to enforce the adoption of this code.

RULES GOVERNING SIGNALS.

Make stroke on bell at regular intervals. Each bar must take the same time as 1 stroke of bell.

When men are to be hoisted or lowered give signal of 3 bells; men must then get on bucket or cage; then give signal to hoist or lower.

Timbers, tools, etc., longer than depth of basket must be securely lashed before being hoisted or lowered.

SECTION 3491. HOISTING ENGINEER.

Same as section 4284, Colorado law.

SECTION 3492. VISITORS.

Same as section 4301, Colorado law.

CHAPTER VII.

ORGANIZATION OF EXISTING STATE MINE-INSPECTION SYSTEMS.

By L. O. KELLOGG.

As this report is concerned with designing a system of State inspection of metal mines that will prove effective, it is a matter of interest and concern to inquire as to what provision is made at present for this purpose in the several metal-mining States. It is found that conditions are as various as the number of States. In many mines, notably in such important metal-producing States as Alabama, California, Kansas, New Jersey, New Mexico, Oregon, Utah, Virginia, Washington, and Wisconsin, there is no permanent inspector whatever whose duties include safeguarding the health and lives of metal-mine workers, although some of these States, such as Alabama, New Mexico, Utah, and Washington, provide with some degree of care for the inspection of their coal mines, which are no more dangerous. Of the other States, Tennessee and Oklahoma provide for the inspection of metal mines by the coal-mine inspectors, and North Carolina makes the commissioner of labor and printing the inspector of mines. This official has never performed the duties of the office because no appropriation has been made therefor. In Wyoming the State geologist is *ex officio* inspector of mines. Oregon supports a bureau of mines and geology but mine inspection is not one of its duties. In two States, although there is no State inspection system, the principal mining counties provide inspectors, whose duties are not unlike those of deputies in a State system. These States are Minnesota, with three such county inspectors, and Michigan, with eight. Systematic State inspection of metal mines is carried on by Arizona, Colorado, Idaho, Missouri, Montana, Nevada, New York, South Dakota, and Tennessee. In Alaska there is a Federal mine inspector working under the jurisdiction of the Federal Bureau of Mines. The California Industrial Accident Commission, acting in conjunction with the Federal Bureau of Mines, in January, 1914, engaged H. M. Wolfelin, mining engineer of the bureau, to make a study of mining conditions in California with especial regard to safety, his salary and expenses being borne jointly by the commission and the bureau.

Notwithstanding the fact that metal mining had been conducted on an extensive scale in many of the States for years before, it was

not until the late eighties that State inspection of metal mines was provided for. Michigan and Missouri were the pioneers, their laws being enacted in 1887. They were followed by Montana in 1888, and by Colorado and Idaho in the next following year. New York passed an inspection law in 1890, and South Dakota took similar action in 1893. The legislation in other States that now have metal-mine inspection departments is of comparatively recent date. Arizona provided for such inspection as soon as statehood was granted, whereas the great mining State of Nevada has had an inspector and deputy inspector of mines only since 1909, and in Minnesota, perhaps our most important metal-mining State, inspection dates only from 1905.

ARIZONA.

Arizona provides rather well for her mine inspection, although she falls considerably short of the recommendations of this committee. In 1913 there was expended for this purpose \$12,571, of which \$3,000 was for the salary of the chief inspector. The number of mines inspected was 84, and the total number of inspections made was 266; that is, the inspection of each mine was made on an average once every four months or somewhat oftener. The law requires that every mine employing 50 or more men shall be visited at least every three months and that every mine employing between 6 and 50 men shall be visited at least once a year. The total number of men employed was 13,933. These figures represent a cost of about \$150 per mine inspected and of about 90 cents per employee.

COLORADO.

The metal-mine inspection of Colorado is in charge of a bureau of mines. The inspection of coal mines is performed by another department of the State government. The appropriation for the bureau is made biennially by the legislature. That for the years 1913 and 1914 was distributed as follows: For salaries of commissioner, four inspectors, secretary, and stenographer, \$24,800; for other expenses, \$10,800; a total of \$35,600. For the two-year period, 1911-12, the total appropriation was \$33,400. No fees are collected except for copying reports, and these are of little consequence. The commissioner is the head of the bureau; each of the four inspectors has jurisdiction over a number of counties. Early in 1914 the inspection list of the bureau contained the names of 737 mines. Each inspector is required to visit every operating mine in his district at least once a year and also to make immediate investigation of all fatal or serious accidents occurring in his district. In 1912 there were 23,004 men engaged in mining, milling, and smelting in the State, and it was thought that the number so employed in 1913 was over 24,500. The annual unit costs are thus \$24 per mine and 70 cents per man.

IDAHO.

The State of Idaho appropriates \$5,000 annually for its mining department. Of this sum \$2,400 is for the salary of the single inspector, who has also to act as State geologist. The number of men employed in connection with the mining industry of the State in 1913 was about 6,200. There are about 900 incorporated development properties and operating mines in the State and it is required by law that among these all that, in the judgment of the inspector, require inspection shall be inspected at least once every year. About 50 are judged to require inspection. The capital of Idaho is 500 miles from the principal mining district, the Coeur d'Alenes. The duties of the inspector are numerous and the appropriation small. For that reason, the single formal inspection is about all that can be undertaken, and serious accidents are seldom investigated unless they occur during the visit of the inspector. The cost per mine would come to about \$100 and the cost per man about 80 cents.

MICHIGAN.

Michigan, under the county inspection system, is by far the most thoroughly inspected State. However, the salaries paid by the several counties are relatively low. As the number of mines to be inspected is small in proportion to the large inspection force, the inspection naturally tends to be more frequent. As a result, although the law requires that each mine be inspected 3 times a year, in practice the mines are inspected 2 to 20 times. Of course, as regards the safety conditions for which the inspector is responsible, the great depth of some of the mines offsets in part their smaller number.

Eight counties in Michigan maintain mine inspectors. In Baraga County, although no active mining is performed, an inspector is found necessary to see that the five mining properties and the one quarry keep their protecting fences in repair. They are visited for this purpose every month. The inspector receives a salary of \$250 per year. The only mining employees are watchmen. Dickinson County pays its inspector \$1,800 per annum, and allows him 4 cents per mile for traveling expenses. The mines in the county employ about 2,700 men, there being 16 mines in operation, some that operate intermittently and some properties in process of exploration. These are inspected every 30 days. Gogebie County appropriates \$3,000 per year for mine inspection, out of which \$5 a day is paid to the chief inspector. The 26 mines on the inspection list are visited at least once every 60 days and oftener if necessary; 5,256 men are employed. In Houghton County the chief inspector receives \$150 per month. Each shaft in the county is visited once a month. There are 73 shafts and about 14,000 employees. Iron County expends \$5,000 annually for mine inspection. There are a chief inspector and two deputies,

the former receiving \$2,400 per year. There were 36 active and 20 inactive mines in the county at the time information was given, and each of these was inspected at least once a month and some even once every 20 days. The average number of men employed was 3,667. In Keweenaw County the single mine inspector receives a salary of \$1,700 and visits the four properties on his list at least once every 30 days. The number of employees is normally about 2,500. The inspector of Marquette County receives an annual salary of \$2,000, the total annual expenditure being about \$2,350. He has 43 mines and 6 quarries on his list, which are visited at least once every 60 days and frequently oftener. The number of employees is 5,300. Ontonagon County appropriates \$800 per year for mine inspection. The single inspector under normal conditions has about 11 mines to visit, the number of employees being about 700. The total number of mines and quarries to be inspected in the State is about 241 and the number of employees about 34,100. The total expenditure being somewhere around \$20,200, the costs per mine and per man are approximately \$84 and 60 cents.

MINNESOTA.

Although Minnesota maintains a department of mines and minerals, this is concerned solely with the administration of the State's ore lands, the work of inspecting the mines as to their safety being in the hands of county inspectors. There are three of these for the three principal mining counties, St. Louis, Itasca, and Crow Wing. The inspector for St. Louis County, comprising the central and eastern part of the Mesabi Range and the Vermilion, receives \$2,000 for salary and \$600 for traveling expenses. For 1913 he had on his list 119 mines, of which 99 were operating and were visited every 90 days. The number of employees for that year was 16,048. The inspector for Itasca County, the western end of the Mesabi Range, receives a salary of \$1,200. There were in the county in 1913, 20 mines, which he visited two or three times a month. In that year 2,600 men were employed. The inspector for Crow Wing County, the Cuyuna Range, receives a salary of \$1,000. He visits the 16 mines on his list every two months or oftener when necessary. In 1913 about 1,400 men were employed in and about the mines of the county. The total expenditure for inspection in Minnesota is probably about \$5,250, the number of mines inspected 155, and the number of employees 20,045. The cost per mine would be about \$34 and per man about 26 cents.

MISSOURI.

Missouri has recently increased the number of lead and zinc inspectors from two to four and created the office of chief inspector, bringing the State in line with the States of Colorado and Arizona as

regards the number of inspectors. She provides liberally for the inspection of her mines and the inspection is thorough. The annual appropriation is \$17,600. There is a chief inspector receiving a salary of \$2,000, and six deputies, receiving \$1,800 each; two of the latter, however, are assigned to coal mines. The inspection list contains the names of about 650 mines, and each of these is visited from two to four times a month. The total number of men employed in connection with the metalliferous mines is about 20,000. If the number of metal mines be taken at 500 and the expenditure on this inspection put at \$11,920, the costs per mine and per man amount to \$24 and 60 cents.

MONTANA.

Montana appropriates \$6,000 for mine inspection. Of this sum, the chief inspector receives \$2,500 as salary and the single deputy \$2,400. The inspection list contains the names of 352 mines, each of which is required by law to be visited at least once a year; in practice the most important are visited three times a year. It is estimated that the metal mines of the State employ about 15,500 men. The unit costs would be \$17 per mine and 39 cents per man.

NEVADA.

The annual appropriation in the State of Nevada is \$9,500. The inspection force consists of the chief inspector and one deputy, the former receiving a salary of \$3,600 and the latter \$2,400. There are about 450 mines on the inspection list, each of which is visited at least once a year, and oftener if the method of working or the character of the ground requires it. The number of men is about 5,000. The costs are therefore about \$21 per mine and \$1.90 per man.

NEW YORK.

Mine inspection in New York is carried on by the State department of labor. There is a single inspector whose salary is \$1,800 a year together with traveling expenses. There are about 45 mines operating in the State and requiring visiting, and in the spring, summer, and fall over 200 quarries are worked, their inspection falling within the province of the department. The number of men employed in the mines of the State in 1913 was 3,344 and the number employed in quarries 5,156. The annual expenditure is about \$2,400; and if the quarries be considered equivalent to half a mine each, and the quarry employees similarly reduced, the costs would be about \$16.50 per mine and 40 cents per man.

SOUTH DAKOTA.

South Dakota, whose mining industry is concentrated in a relatively small area, appropriates \$2,350 for mine inspection. The single inspector receives a salary of \$1,600 per year and is allowed 10 cents per mile for traveling expenses. There are 45 active mines

requiring inspection. Although the law stipulates that every mine be inspected at least once a year, the inspector endeavors to visit once in three months each mine that employs more than 10 men. The number of men employed in mining is about 2,800. Hence the costs approximate \$52 per mine and 84 cents per man.

TENNESSEE.

The State of Tennessee has a well-developed system of inspection and provides generously for the compensation of the inspectors, but the most of their activities are concerned with coal mines. The mining department has charge of coal, metal, and other mines, and does a good deal of work of a statistical nature in connection with the mineral production of the State, besides looking after inspection. The staff consists of a chief inspector, receiving a salary of \$3,000, two field district inspectors, and one office district inspector or statistician, receiving salaries of \$2,000 each, a clerk, and a stenographer. The various mines have to pay fees for their inspection, the income from this source helping largely to support the department. In 1912 there were 17 iron, copper, phosphate, and zinc mine openings visited. One to two inspections were made of each mine. The total number of employees was about 1,000. The ratio of coal-mine inspections to metal and other mine inspections is about 14 to 1, a fair measure probably of the cost of the two classes and their share in the work of the bureau.

NUMBER OF INSPECTORS.

The inspection forces of Michigan, Missouri, Arizona, and Colorado are large as compared with those of Idaho and New York, where one inspector is required to cover the entire State, or with that of Nevada, where two inspectors are compelled to examine about 450 mines between them. Taken in connection with the requirements imposed by statute of collecting a large amount of statistical data with little or no clerical help, it will be readily seen how impossible of adequate accomplishment is the task set the inspector in the States where only one such is employed.

METHODS OF SELECTING INSPECTOR.

As to the manner of selection for office, the States are evenly divided, about half providing for the election of the inspector, the other half providing for his appointment, usually by the governor. Michigan in 1911 went over to the elective system after having had the inspector for 24 years selected by the county supervisors. With the exception of Oklahoma, where the deputy inspectors are also elected, the chief inspector is in all cases empowered after election to appoint his own deputies. This is also true of all the States where the inspector is appointed by the governor, with the exception of Montana, where the governor also appoints the deputy. This arrangement is wrong

in principle, inasmuch as the man in charge should unquestionably have the right to select his own subordinates if he is to be held responsible for the proper discharge of the duties of the office.

SALARIES OF INSPECTORS.

As regards salaries, there is the greatest disparity in the laws of the several States. Nevada pays the maximum, \$3,600, while two other States allow the chief inspector \$3,000, these being Arizona and Colorado. The remaining States allow annual salaries varying between \$1,000 and \$2,400. The deputies appear to average about \$1,800 per year, Nevada and Montana paying the maximum of \$2,400. A Michigan deputy at \$3.50 per day would average between \$1,000 and \$1,300 per year. It is somewhat remarkable that with the present scale of salaries the States can attract men as well fitted for their positions as many of them are. Nevada has set an excellent example of generosity, which could be followed by her sister States to their ultimate advantage.

Although it has not proved possible to obtain complete data covering the first appropriations made for metal-mine inspection, yet insofar as such information has been obtained, it shows that the amounts have remained practically constant from the beginning, the increase, if any, being only three or four thousand dollars. Not only is this true, but the amounts seem entirely inadequate when the value of the mineral production in these States is taken into consideration. Even Michigan, the most generous State, spends only a little over \$20,000, as against a mineral production that would be valued at about \$77,000,000 on the most conservative basis. In one State, New York, the annual appropriation is less than two-thirds what it was 24 years ago. The annual appropriations as a whole vary between \$5,000 and \$16,000, with more States under the \$10,000 mark than over it. It is apparent, with the number of mines running into the hundreds, employing several thousands of men in the most hazardous of occupations and adding annually millions to the wealth of State and Nation, that such appropriations are wholly insufficient to care for the responsible work of inspection, and are utterly incommensurate with the importance of the industry and the severity of the hazards.

Not alone are the most of the salaries too low to be attractive, but the same deficiency exists as regards the length of the term of office, tending to prevent its being filled by men who might otherwise be induced to accept the place. In only two States is the tenure of office indefinite. In three States it is four years, but in the others it is only two.

FREQUENCY OF INSPECTION.

In the matter of the frequency of inspection there is great variation. Michigan's law is the most exacting, requiring not less than six in-

spections a year. Most of the States require only that each mine be inspected at least once a year. Several specify that the inspector visit each mining county once a year and inspect such mines as in his judgment require it. It is a fact, however, that almost all the inspectors are much more diligent in their inspecting than the law requires them to be, usually exceeding the stipulated number of inspections from two to four fold.

TABULATED SUMMARY OF RESULTS OF INQUIRY.

A table summarizing the results of the inquiry is appended. It shows in detail the chief features of the inspection systems of the States that maintain separate metal-mine inspection departments.

It will be noted that the cost of inspection per mine ranges from \$16.50 in New York to \$150 in Arizona, and the costs per man, from 26 cents in Minnesota to \$1.90 in Nevada. The averages would be about \$34 and 53 cents. The generosity or niggardliness of the various State or county governments is not the only factor causing these extreme variations. Thus a State in which the mining industry is concentrated within a small area can conduct efficient inspection most cheaply. This condition exists in South Dakota and the fact that both figures are about an average for that commonwealth indicates that inspection is thorough, measured by the present standards of American practice. A State with its mines scattered in all quarters or remote from the seat of government must expect to pay more for its inspection; such States are Idaho, Nevada, and Arizona. Again, in the more thickly settled communities, travel is in general faster and cheaper and inspection correspondingly cheaper, as in New York. If the mines of the State are large and few, the cost of inspection per mine will usually be high and the cost per man be low. However, other factors may conflict with the operation of this rule. Thus in Minnesota, while the mines are very large, they are concentrated and the appropriations for inspection are not generous; consequently both costs are low. In Arizona, on the other hand, although the same condition exists, the industry is scattered and generous appropriations are made, so that both costs are high. Where there are many small mines, as in Colorado and Missouri, the cost per mine is low, although both of these Commonwealths make relatively large appropriations.

It should be remarked that too much significance can not be attached to the figures under discussion, because the number of mines, the number of employees, and even the amount expended are estimated in many cases. The average of 53 cents per man is an excellent criterion of the attention that safety work is at present receiving at the hands of the State governments. It is ridiculously low; \$2 per man would not be any too much to pay for inspection; money wisely expended in this work is sure to be ultimately a paying investment.

Data on metal-mine inspection systems of various States.

State.	Date of first mine-inspection law.	Date when first inspector was appointed.	Amount of first annual appropriation.	Amount expended in 1913.	Date of passing existing mine-inspection law.	Number of inspectors.	Manner of selecting inspectors.	Manner of selecting deputies.	Term of office of inspector.	Term of office of deputies.
Arizona.....	1912	1912	\$10,800	\$12,571	1912	4	Elected.....	Appointed by inspector.	Years. 2	.....
Colorado.....	1889	1889	12,500	17,800	1911	5	Appointed by governor. ^a	Appointed by commissioner. ^b	a 4	b 2
Idaho.....	1889	1889	3,000	5,000	c 1899	1	Elected.....	.....	.....	.....
Michigan:										
Baraga County.....	1887	.....	.....	250	1911	1	.....	.....	2	.....
Benjamin County.....	1887	1887	1,400	a 1,800	1911	1	.....	.....	2	.....
Cochran County.....	1887	1887	.....	3,000	1911	2	.....	Appointed by inspector.	2	(c)
Houghton County.....	1887	1889	.....	4,350	1911	3	.....	.....	2	(c)
Iron County.....	1887	1890	400	5,000	1911	3	.....	.....	2	(c)
Keweenaw County.....	1887	1887	100	a 1,700	1911	1	.....	.....	2	(c)
Marquette County.....	1887	1887	.....	2,350	1911	1	.....	.....	2	(c)
Ontonagon County.....	1887	.....	.....	d 800	1911	1	.....	.....	2	(c)
State.....	1887	.....	.....	f 20,200	1911	13	.....	Appointed by inspector.	2	.....
Minnesota:										
Crow Wing County.....	1905	.....	.....	d 1,000	1905	1	.....	.....	3	.....
Itasca County.....	1905	1905	.....	a 1,200	1905	1	.....	.....	3	.....
St. Louis County.....	1905	1905	.....	2,600	1905	1	.....	.....	3	.....
State.....	1905	.....	.....	f 5,250	1905	3	.....	.....	3	.....
Missouri.....	1887	1887	.....	f 11,320	1899	5	Appointed by governor.	Appointed by chief inspector.	4	.....
Montana.....	1888	1889	1,800	6,000	1910	2	.....	Appointed by governor.	4	4
Nevada.....	1909	1909	9,000	9,500	1911	2	Elected.....	Appointed by inspector.	4	4
New York.....	1890	1893	4,000	2,400	1909	1	Appointed from civil service list.	.....	(g)	.....
South Dakota.....	1893	.....	.....	2,350	.....	1	.....	.....	.....	.....

State.	Annual salary of inspector.	Annual expenses deputies.	Traveling expenses allowed.	Number of times each mine must be visited yearly.	Approximate average number of times each mine is actually visited yearly.	Number of mines and quarries to be inspected.	Number of men employed.	Approximate cost of inspection per mine.	Approximate cost per employee.
Arizona.....	\$3,000	\$1,800	\$1,400 each Commissioner, \$1,000; inspectors, \$1,200.	(b)	3	84	13,933	\$150.00	\$0.90
Colorado.....	a 3,000	b 1,800	\$900.	1	2	737	24,500	24.00	.70
Idaho.....	2,400			1	1	450	6,200	100.00	.80
Michigan:									
Baraga County.....	250		4 cents per mile	6	12	6	710		
Dickinson County.....	1,800		do.	6	12	16	2,700		
Gogebic County.....	(c)	(c)	do.	6	k 6	26	5,256		
Houghton County.....	1,800	(c)	do.	6	k 12	733	14,000		
Iron County.....	2,400	(c)	do.	6	k 12	56	3,667		
Keweenaw County.....	1,700		do.	6	k 12	4	2,500		
Marquette County.....	2,000		do.	6	k 12	49	2,000		
Ontonagon County.....	800		do.	6	k 6	11	700		
State.....			do.	6		241	34,133	84.00	.60
Minnesota:									
Crow Wing County.....	1,000				k 6	16	1,400		
Itasca County.....	1,200				4	20	2,600		
St. Louis County.....	2,000		\$600.		24	119	16,015		
State.....						155	20,045		.26
Missouri.....	2,000	1,800	\$1,200.		24 to 48	m 650	20,000	34.00	.60
Montana.....	2,500	2,400		1	n 3	352	13,300	21.00	.39
Nevada.....	3,000	2,400	Actual expenses.		k 1	460	5,000	21.00	1.90
New York.....	1,800		10 cents per mile.	1	q 4	(p)	16,50	16.50	.40
South Dakota.....	1,600					45	2,800	52.00	.84

a Head of department with title of commissioner.

b Assigned to certain districts with title of inspector.

c As amended since.

d And expenses.

e Option of inspector.

f Estimated.

g Indefinite.

h Once; four times if mine employees over 50 men.

i Out of 900 properties; the law requires that only those be visited for which the inspector judges it necessary.

783.50 per day.

k Or more as necessary.

l Shifts.

m Probably includes coal mines.

n Applies to the more important mines.

o 45 mines; about 200 quarries which do not operate in winter.

p 3,341 in mines; 5,156 in quarries.

q Applies to mines employing more than 10 men.

CHAPTER VIII.

STATISTICAL DATA ON FATAL AND NONFATAL ACCIDENTS.

By C. B. DUTTON.

ACCIDENT STATISTICS OF VARIOUS COUNTRIES.

The accompanying tables were compiled for the purpose of showing by figures covering an extended period of years the comparative death and injury rates in the metal mines of the United States and of foreign countries. It was considered that such a comparison would indicate forcibly the necessity for the adoption of a general code of safety rules and regulations such as are contained in the proposed draft of a law prepared by the committee.

Table 6 clearly shows that metal mining in the United States and Canada is a more hazardous occupation than in any other country, with the sole exception of the Transvaal, where the conditions are wholly dissimilar and where the bulk of the mine labor is composed of the native colored races.

The excessive death rate in the metal mines of the United States may be readily analyzed by an examination of this table. The number of men shown to have been employed in the metal mines of the United States for the period 1894-1911 is little in excess of the number of men employed in the metal mines of Australasia for the same period, yet nearly two and one-half times as many men were killed in the mines of the United States as in those of Australasia. In Great Britain, with approximately one-half as many men in the metal mines, less than one-fifth as many were killed in that period. In India, with approximately one-third the number of men in gold and mica mines, less than one-fifth as many men were killed as were killed in the United States. In Austria, with about one-eighth as many men, less than one-twenty-sixth as many were killed. In Russia, with approximately two thirds as many men, less than one-fifth as many were killed. In Italy, with a little more than one-half as many men, less than one-third as many were killed.

These showings are significant enough, but when it is taken into consideration that the total number of lives lost in the United States for this period would probably be between nine and ten thousand if complete returns were obtainable, the comparisons shown in the table become all the more striking.

The high death rate in the United States and Canada is probably to be partly explained by the fact that mining in these two countries is only in its infancy as compared with the continental countries generally, both countries having only recently passed beyond the first stage in the exploitation of their vast virgin resources; this has made a high state of discipline and effective mine regulation on the part of both the State and the operator extremely difficult in the past. Although conditions have changed, many of the objectionable features of the earlier days still continue. It must be admitted, however, that in comparison with Australasia this explanation will not hold, inasmuch as those States are even younger than the United States and are less developed. Possibly the great proportion of English-speaking laborers there employed is largely responsible for the excellent showing that Australasia makes. The more stable expansion and development of the industry, which is bound to come with the opening of new fields of usefulness for our mineral resources, and with improvements in metallurgical practices, will bring in its train a higher degree of intelligent supervision and regulation than the past has afforded. The high death rate attendant upon the first stage in the development of a new industry so inherently dangerous as the mining industry is not peculiar to this country, but has been characteristic of the mining industry everywhere.

In addition to this reason for the high death rate in English-speaking North America there is the great difficulty in maintaining discipline among mine employees. This is especially true in the United States, where a mistaken spirit of independence leads the miner to refuse observance to sensible rules devised for his own protection. This matter is discussed more at length elsewhere in this report.

It should be noted that all the death and injury rates here listed are referred to the number of employees. It is often urged that such rates should be calculated to the number of tons of product. As regards pure theory this method is probably logical. A cold-blooded statement would be that a certain sacrifice of human life and limb is necessary to produce the world's metal. By working at high speed the number of tons of product per shift of work can be increased, but the hazards of the work are also increased or are likely to be increased thereby. If the relative increases of production and accidents be such that the accident rate per 1,000,000 tons, say, remains the same, the result is the same as regards society at large, yet the showing per 1,000 men employed or per 300,000 man-shifts of work is worse. Such an increase is actually what happens to a certain extent in this country.

There are two objections to the employment of this basis of comparison. The first is that it tends to justify unnecessary risk on the

ground that increased production more than compensates for an increased hazard. There is thus a tendency to a letting down of the bars. Furthermore, humanitarian considerations require that deaths and injuries be viewed as a absolute loss to mankind rather than as a measure of the cost of the wealth produced. The second objection is of more immediate weight; the rates have not been thus calculated at all generally and figures are therefore not available.

It would be desirable to collect statistics bearing on the death and injury rates per unit of production hereafter and present them along with the rates based on the number of employees. Such a practice would give a better opportunity of judging the actual conditions existing and of making comparisons between different countries and different districts. On a tonnage basis, the showing of the United States would be greatly improved. Unquestionably, in the United States and Canada, a greater tonnage per man is produced than anywhere else in the world; it is probably greater even than in Australasia, but probably also is not enough greater to overcome the far lower accident rates existing there. The showings of such countries as India and South Africa would be far worse, where the low efficiency of the native labor results in an extremely low tonnage per man. The showings of England and continental Europe would also be relatively poorer, as efficiencies there are admittedly lower. Yet it is doubtful whether even the adoption of the tonnage basis of comparison would result in actually changing the respective positions of the several countries mentioned, arranged in the order of the magnitude of their mining death rates.

With the noticeable and increasing interest in the subject of mine-accident prevention on the part of the average operator and mine manager, and a growing sense of personal responsibility on their part whenever a fatal accident occurs in the mine under their charge, we may reasonably expect a gradual reduction in the annual death rate in metal mines, which will compare favorably with the steadily decreasing death rate in the coal mines of the country.

COMPARATIVE DEATH RATES IN COAL AND METAL MINES.

In the United States, the absence of spectacular metal-mine disasters, which would attract public attention to the loss of life in such mines, has caused the occurrence of fatal and nonfatal accidents therein to receive far less attention than the number of such accidents or the importance of the metal-mining industry demands. The figures presented in Table 7 seem to establish that the loss of life in metal mines is somewhat higher in comparison with the number of men employed, than is the loss of life in coal mines, and that this is true not for any one year only, but for the entire period of eighteen years covered by the table.

This statement is based on the fact that the yearly rates and total average rate for the metal mines of the United States are unquestionably too low, as some States include millmen and smelters in the total number of men employed, whereas others include a small number of quarrymen, and an estimated number of men engaged in prospecting, without, however, including the injuries occurring to these classes of persons, thus swelling the total of those engaged in the mining industry, but also lowering the death rate per 1,000 men employed. It gives an incorrect value to the occupational hazard of the miner to include those engaged in mills and smelting plants in arriving at the total number of men employed in and about the mines, even where the accidents to such employees are reported, as such accidents are relatively few compared with true mining accidents, and the inclusion of such figures results in a more favorable showing in a comparison of death and injury rates in the mines than the State is rightly entitled to claim.

If doubtful figures could be rejected and the list of deaths and injuries confined to true mining accidents, there is every reason to believe not alone that the annual rates would be higher, but that the total average fatality rate for the period 1894-1911 would not be less than 4 per 1,000 men employed in the metal mines of the United States, as compared with 3.51 per 1,000 employed in the coal mines for the period 1896-1911.

One other consideration, however, tends to make the case better for the metal mines as compared with the coal mines. This is the fact that the metal mines work on the average more days in the year than do the coal mines. Thus the metal-mine employees are exposed to more risk than the coal-mine employees. The difference is well analyzed in Technical Paper 61 of the Bureau of Mines.^a If both classes of employment are reduced to a common time basis, the injury and death rates for coal mining are increased relative to those for metal mining. The most convenient time basis is 300 days. Suppose, for example, a mine with 1,000 employees to have worked 300 days in the year and to have had 4 accidental deaths. Its rate is 4 per 1,000. Suppose another mine with 1,000 employees to have worked 200 days and to have had 4 deaths. Figured in the ordinary way, its rate is also 4 per 1,000. But the miners in the second mine were exposed to risk for only two-thirds of the time that the men of the first mine were. By reduction to the 300-day basis, the first rate is unchanged, the second rate is divided by 200 and multiplied by 300, with a resulting rate of 6 per 1,000. This is evidently a fairer basis of comparison. It amounts to calculating the rate per 300,000 man shifts of work.

^a Fay, A. H., Metal mine accidents in the United States during the calendar year 1912. 1913, 76 pp.

It is most desirable that this basis be adopted for future calculations in all States of this country and in other countries as well. It will tend to eliminate many discrepancies and to show true conditions in the industry. When the number of injuries or deaths is calculated merely to the 1,000 men employed without regard to the number of days of work, the intermittently working mine is unduly favored and makes a better showing than the one working steadily.

SOURCE OF STATISTICS.

The figures contained in the tables following were compiled directly from the several official reports, save as otherwise indicated, with the exception of the figures for the continental countries, and the British colonies outside of Canada and Australasia, which were taken from the reports published by the British Home Department. The figures relate to metal and miscellaneous mineral mines only. All quarry and coal mining figures have been excluded, as well as figures for cement plants, limekilns, brick works, etc., which are included by some countries. This selection has resulted in the rejection of figures for some countries where the coal and metal mining figures have been lumped together.

FATALITY RATE IN THE UNITED STATES.

It has proved impossible to obtain complete and accurate figures for the entire United States for the period 1894-1911. Many of the States did not have official mine inspection until within the last decade. Other important mining States, such as California, Alabama, and Utah have had no mine inspection up to the present time, except that California has just made a survey of conditions in her mining industry as regards safety; hence statistics for these States are unprocureable. At the time the figures were obtained, furthermore, Arizona had not organized an inspection system and no statistics were available from that State. In other instances it has been impossible to obtain the desired data for some of the early years, no record either having been kept or being now available. The figures given are therefore for those States in which there was inspection service.

It is discreditable that such meager returns should be available for the metal-mining industry in the States generally. Even when official reports are published, the results for the entire State are usually lumped together, so that no differentiation can be made among the several industries, such as copper mining, iron mining, and precious-metal mining. In this respect the corresponding reports for the Canadian Provinces and Australian Colonies are in striking contrast. There is no satisfactory reason why returns should be made of the accidents occurring in the coal mines of Alabama and Utah, for example, and not in the metal mines of those States; and

why no returns at all should be made for such an important mining State as California. Now that the Bureau of Mines has started to collect annual statistics concerning metal-mining accidents it will be possible hereafter to present the data in as great detail as is customary in some of the other countries.

It is shown by the data available that the death rate in the metal mines of the United States is 3.28 per 1,000 men employed for the total period. As suggested, if accurate and complete figures were obtainable, the average for the period would unquestionably be closer to 4 per 1,000.

Table 8 gives the deaths by years and States for the entire United States so far as statistics are available. There was no official inspection of mines in Minnesota until the latter part of 1905, and none in Nevada until 1909. Figures for Idaho are available only from 1903 onward, as the first inspector did not publish accident statistics. In Tennessee metal mines are inspected by the coal-mine inspectors. Both Michigan and Minnesota have the county-inspection system, and the returns of those States are made by counties for that reason. The first mine inspector in Michigan was appointed in 1887. Although, as previously stated, the figures are necessarily incomplete, they show that a total of 5,764 deaths occurred in the metal mines of the United States for the period 1894-1911. If complete figures were available it is probable that the true total would be between 9,000 and 10,000.

The publication of the figures of metal-mine accidents for 1911 by the Bureau of Mines affords an interesting check on the results recorded in this table. The figures gathered directly from the operators show a total of 695 deaths, as compared with 427 deaths for the States represented in Table 8. This is a difference of over 250 for the year and accounts for the difference in the death rates of 4.19 and 3.46 for this particular year. Assuming that this difference held throughout the entire period covered it would make a difference in the total of over 4,000 deaths.

Table 9 gives the numbers killed per 1,000 men employed in the mines of the United States for the period 1894-1911. The highest single death rate recorded is 82.35 for iron mining in New York State for 1895. This is extremely high, but the report shows that out of the total of 340 men employed, 28 deaths occurred, 26 of these deaths being due to falls of rock. The next highest rate is that of 14.72 for the iron mines of Iron County, Mich., for the year 1904. The highest average rate for the States included in the table is 4.67 for the iron mines of Minnesota. Michigan has the next highest rate, 3.83. The lowest rate for any State is that for Tennessee, which is 0.80; this extremely low rate is probably due to the large number of men engaged in phosphate mining, in which the hazards are slight. The

rates for the miscellaneous mineral mines of Tennessee for the period is only 0.66, only two deaths being recorded for the entire period. The average rate for Colorado, 2.79, is undoubtedly low because of the inclusion of figures covering the men employed in mills and smelting plants. It is probable that the true rate for the miners and mine workers alone would approximate 3.50. The highest rate for Colorado is shown to be 4.03, whereas the lowest is 1.96 for 1908. Idaho has a low average rate of 2.51, its highest rate being 3.50 for the year 1905. The iron mines of Michigan show for the period the very high average rate of 4.70. This is much higher than the corresponding rate for the copper mines of Houghton County, which is 3.05. The highest average rate for any of the Michigan counties is that for Iron County, which is 7.55. The highest rate for Minnesota is 7.25 for the year 1906, and the lowest rate is 2.76 for 1904. The lead and zinc mines of Missouri make a favorable showing with an average of 3.11, as compared with the general average for the mines of Michigan, Minnesota, and Montana. The highest rate for Missouri is 4.52 for the year 1905, and the lowest rate is 1.29 for the year 1903. The iron mines of New York show the high death rate of 5, which is 0.30 higher than the rate for the iron mines of Michigan. South Dakota shows the relatively low death rate of 2.49, the lowest rate being that for the year 1910, which was 1.20. The copper mines of Tennessee show for the entire period a death rate of 4.36, which is 1.31 higher than the rate for the deep copper mines of Houghton County, Mich. The iron mines of Tennessee show the low average death rate of 0.36, as compared with 4.70 for Michigan and 5 for New York.

The highest death rate for any one year for the entire United States as shown by this table is 5.91 for the year 1895, and that for the year 1899 is the lowest, 2.19. The average rate for the decade 1894-1903, inclusive, is 3.28, and the rate for 1904-1911 is the same, so that the average is consistently high for the entire period. For the purpose of comparison Table 10 is inserted showing the number of men employed and the number of men killed and the death rate per 1,000 men employed for the calendar year 1911. This shows a death rate of 4.29 for the iron mines of the United States, as compared with 4.70 for the iron mines of Michigan for the entire period. Precious-metal mines show an average death rate of 3.95 for the year, which is not far from what the true average death rate would be for the precious-metal mines of some of the western States if the list of accidents were confined to those employed in the mines solely.

FATALITY RATES IN BRITISH NORTH AMERICA.

Tables 11 and 12 show the number of men killed in the metal and nonmetal mines of British North America for the period 1894 to 1911,

inclusive, classified by years and industries. The rates for Ontario and British Columbia are shown to be extremely high, or 3.98 and 4.23, respectively. The highest death rate for any one year is that of 32.61 for gold mining in Ontario during 1894. This does not give a true idea of the hazards of that industry owing to the very small number of men employed. The figures for British North America fluctuate greatly, being extremely high for one year and running very low for another year. For example, the highest rate for Ontario is 8.94 for the year 1894, while the lowest rate is 1.07 for 1905. Silver mining in Ontario gives the high average death rate of 6.86 for the entire period.

FATALITY RATES IN GREAT BRITAIN AND BRITISH COLONIES.

Tables 13 and 14 show the number of men killed in the metal and nonmetal mines of Great Britain, Australasia, and other British colonies for the period 1894-1911, together with the death rates per 1,000 men employed. Two sets of figures are presented for Great Britain for the reason that the mine inspection law makes an arbitrary distinction between metalliferous and coal mines. Mines where associated minerals are found in connection with the coal come under the coal mines regulation act. The figures for iron and other mines, therefore, represent the fatalities in all mines other than coal, and show approximately twice as many deaths as occurred in the mines covered by the metalliferous mines regulation act. Approximately two-thirds of the deaths occurring in the mines covered by Table 13 occurred in the gold mines of the Transvaal, the annual high death rate for which has already been commented upon.

The most striking thing in connection with Table 13 is the consistently low death rates for the mines of Great Britain and Australasia. There is not the fluctuation observed in the death rates for the mines of the United States and British North America. The highest death rate for all Australasia is that of 3.65, for the silver mines of New South Wales for the year 1901. The total average for Australasia of 1.38 for the entire period is extremely low and shows the result of intelligent supervision, rigorous inspection, strict discipline, and painstaking effort to reduce the number of fatalities and injuries in the mines.

FATALITY RATES IN EUROPEAN COUNTRIES.

Tables 15 and 16 show the number of men killed in and about the metal and nonmetal mines in various foreign countries together with the relative death rate per 1,000 men employed. The same consistently low death rate commented upon in the case of Australasia and some of the other British colonies is exhibited in these tables and makes it evident that intelligent effort and cooperation can reduce

the death rate in American metal mines to a comparably low figure. The ore and other mines of Austria show a low average of 6.90 for the period. The iron mines of Austria have a total average of 1.35 for the period, the iron mines of Prussia 1.09, and the iron mines of Saxony 0.87, as compared with 4.70 for the iron mines of Michigan, and 5.10 for the iron mines of Ontario.

INJURY RATES IN THE METAL MINES OF THE WORLD.

Tables 17, 18, 19, 20, 21, and 22 give the number of men injured in and about the metal mines of the United States, British North America, Great Britain, Australasia, and other foreign countries for the period 1894-1911 together with the number injured per 1,000 men employed. Comparisons of injury rates are extremely unsatisfactory because of the lack of uniformity in the reporting of injuries and because of the absence of any accepted standard as to what constitutes a serious injury or a slight injury. A number of the States in the United States report only serious injuries and ignore slight injuries. For example, in the biennial report of the commissioner of labor of Minnesota for the years 1909 and 1910 it is stated that from August 1, 1909, to July 31, 1910, 4,425 accidents occurred in the iron mines of the State, of which about 1,500 were serious or severe injuries. The reports of the county inspectors of mines for St. Louis and Itasca Counties for the years 1909 and 1910 show approximately only 1,000 injuries as having occurred in the mines under their jurisdiction for these *two* years as against the one-year figures of the commissioner.

Great Britain reported 307 injuries in mines coming under the metalliferous mines act, for the year 1907, whereas for the following year 1,497 serious injuries were reported. The reason for the marked increase was that beginning with 1908, an injury occasioning the loss of seven days' time was classed as a serious injury and operators were compelled to report it as such, whereas prior to that time it was apparently left to the judgment of the operator to report what he considered a serious accident.

An examination of the reports of the inspectors for Houghton and Dickinson Counties, Mich., which incidentally are the only reports giving the number of injuries in the metal mines of that State, makes it apparent that only a very small percentage of injuries are brought to the inspectors' attention. It will hardly be credited that only five or six accidents resulting in the injury of employees happened in the mines of Houghton County when 30 or 40 men were killed during the same year. Over any extended period of years the injuries must greatly exceed the deaths, and yet if these figures are to be accepted the opposite is true.

The foregoing discussion is sufficient to make it evident that the figures presented are both unsatisfactory and unreliable. In many cases the reports do not distinguish between serious and slight acci-

dents and therefore both serious and slight injuries have had to be lumped together.

Notwithstanding these facts, the figures presented in the accompanying tables clearly show that even with the incomplete returns at hand and the lack of uniformity in the method of reporting accidents, the injury rates for the United States and for British North America are relatively higher than the corresponding rates for Australasia and other European countries, and if correct figures were available, would undoubtedly be shown to be as much higher as the death rates for both are higher than the death rates for the rest of the world. It seems to be apparent from a perusal of the reports of accidents for Australasia that a much higher degree of regulation of mining practices is possible there, and that a more rigid compliance with the provisions of the law is insisted upon than is the case in the United States. This in all probability accounts in considerable measure for the differences both in the fatality and nonfatality rates.

Table 17 shows that over 9,350 men were injured in the metal mines of the United States (States having mine-inspection service only) during the period 1894-1911, and it is probable that if the complete figures were at hand more than twice that number of men would be shown to have been injured. Practically all of the injuries included in Table 17 are of a serious character, involving loss of limb, destruction of eyesight, etc. Two-thirds of the injuries reported are shown to have occurred in the mines of Colorado. The figures are therefore necessarily unsatisfactory, but they are as complete as it is possible to get them.

Table 18 gives the relative injury rates per 1,000 men employed in the mines of the United States. An interesting comparison is afforded by the rates for St. Louis and Itasca Counties, Minn., for the years 1909, 1910, and 1911. The reports for Itasca County include slight injuries, whereas the figures for St. Louis County give serious injuries only; therefore the injury rates for the former are greatly in excess of those for St. Louis County. In 1898 and 1899 the commissioner of labor of Minnesota reported both serious and slight injuries, which accounts for the high injury rate for those two years and the low injury rates thereafter.

Tables 21 and 22, Western Australia, show the largest number of injuries for Australasia, the total of 3,839 amounting to more than one-third of the total injuries in all Australasia. The total injuries for Queensland and Western Australia amount to almost two-thirds of the injuries for Australasia, whereas the injury rates are from two to five times as high as for the other States.

Tables 23, 24, 25, and 26 give the number of men employed by years in the metal mines of the world from 1894-1911. The tables show a gradual decrease in the number of men engaged in mining from 1907 on throughout all the mining countries generally.

TABLE 6.—*Number of men employed, deaths, and death rate per 1,000 men employed in and about the principal metal and nonmetal (except coal) mines of the world for the period 1894–1911, inclusive.*

Country.	Total number employed.	Number of deaths.	Death rate per 1,000 men employed.
United States ^a	1,748,962	5,764	3.28
British North America.....	200,414	672	3.35
Great Britain and certain British Colonies:			
Great Britain ^b	827,564	1,143	1.38
Australasia.....	1,638,017	2,255	1.38
India ^c	586,895	1,110	1.89
Transvaal.....	1,778,351	8,475	4.77
Total ^d	5,516,868	13,680	2.50
Austria.....	296,851	217	.90
France.....	300,126	643	2.14
Italy.....	986,391	1,582	1.60
Japan ^e	701,506	1,081	1.73
Russia ^f	1,127,491	1,151	1.02

^a Figures incomplete; include only States having mine inspection.^b Figures include all mines except coal mines.^c Gold and mica mines only, and for period 1898–1911, including Mysore gold mines.^d Includes Australasia, India, Ceylon, Gold Coast, and Transvaal.^e 1902–1910, inclusive.^f 1901–1910, inclusive.TABLE 7.—*Comparative death rates per 1,000 men employed in and about the metal and coal mines of the United States,^a 1894–1911.*

Year.	Metal mines. ^b	Coal mines. ^c	Year.	Metal mines. ^b	Coal mines. ^c
1894.....	3.58	.....	1904.....	2.88	3.50
1895.....	5.91	.....	1905.....	3.44	3.63
1896.....	4.30	2.84	1906.....	3.62	3.35
1897.....	3.57	2.53	1907.....	3.42	4.88
1898.....	3.47	2.72	1908.....	2.64	3.64
1899.....	2.19	3.07	1909.....	3.41	4.00
1900.....	3.08	3.45	1910.....	3.34	3.92
1901.....	3.36	3.25	1911.....	^d 3.46	3.73
1902.....	2.85	3.71			
1903.....	2.82	3.20	Average.....	3.28	3.51

^a Figures cover only States having mine inspection.^b Figures represent death rates for States included in Table 4.^c Figures selected from Coal-mine accidents in the United States, 1896–1912, with monthly statistics for 1912: Horton, F. W., Technical Paper 48, Bureau of Mines, 1913, 74 pp., 10 figs.^d Fay A. H., Metal-mine accidents in the United States during the calendar year 1911: Technical Paper 40, 1913, p. 5, gives 4.19.

TABLE 8.—Number of men killed in and about the metal and nonmetal (except coal) mines of the United States, ^a 1894-1911.

State.	1894	1895	1896	1897	1898	1899	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	Total.
Colorado ^b							107	121	82	67	101	109	82	77	64	51	51	43	1,378
Idaho.....			103	110	108	103				20	10	21	17	18	10	19	12	15	142
Michigan:																			
Dickinson County iron mines.....	6	6	14	10	11	9	19	27	10	16	9	9	15	7	4	2	9	3	186
Gogebic County iron mines.....	3	11	16	c 8	(d)	9	14	18	29	17	15	17	35	22	17	19	31	24	305
Iron County iron mines.....								11	14	19	12	16	15	25	11	16	15	12	166
Marquette County iron mines.....	15	12	25	17	19	26	24	29	29	23	15	22	e 22	e 37	e 16	e 23	e 29	e 32	415
Total for iron mines.....	24	29	55	35	30	44	57	85	82	75	51	64	87	91	48	60	84	71	1,072
Houghton County copper mines.....	22	46	19	26	23	27	36	33	44	33	45	57	42	f 52	f 59	63	67	50	734
Keweenaw County copper mines.....	(d)	(d)	(d)	(d)	(d)	(d)	(d)	(d)	(d)	(d)	(d)	(d)	(d)	(d)	(d)	4	4	6	14
Total for copper and iron mines ^b	46	75	74	61	53	71	93	118	126	108	96	121	129	143	107	127	145	127	1,820
Minnesota:																			
St. Louis County iron mines.....					18	34	42	29	(j)	52	20	(j)	93	79	52	61	71	78	587
Itasca County iron mines.....																11	12	7	30
Total.....																			
Missouri.....	17	23	13	16	18	34	29	29	(j)	52	20	(j)	93	79	52	72	83	85	617
Montana.....	m 27	32	m 64	38	42	48	56	41	715	16	30	49	58	43	46	64	44	34	623
Nevada.....							40	34	47	33	41	n 50	52	o 43	21	p 49	51	48	765
																q 22	10	47	79

^a Figures include only those States having mine-inspection service.

^b Figures include mill and smelting-plant accidents.

^c Great Britain, Mines and Quarries, General Report and Statistics, 1898.

^d Figures unavailable.

^e Include some quarry accidents.

^f One accident listed as nonfatal terminated fatally, making a total of 59 deaths instead of 58 deaths as given in official total.

^g One death reported by inspector not a mining accident.

^h Excluding Keweenaw County, for which figures could not be obtained.

ⁱ Nine months' total only, and includes only accidents reported to commissioner of labor and not the returns obtained by the inspector, as in the previous years.

^j Not reported.

^k Figures cover lead and zinc mines, including fatalities in tale and gypsum mills.

^l One accident listed as nonfatal terminated fatally, making a total of 15 instead of 14, as given in the official total.

^m Includes coal accidents.

ⁿ Detailed list shows 50 deaths instead of 48 deaths, as given in official total.

^o Detailed list shows 43 deaths instead of 42 deaths as given in official total.

^p Detailed list shows 49 deaths instead of 47 deaths as given in official total.

^q Total from Apr. 1, 1909, when mine-inspection law became operative, to Nov. 30, 1909.

TABLE 8. Number of men killed in and about the metal and nonmetal mines of the United States, 1894-1911.—Continued.

State.	1894	1895	1896	1897	1898	1899	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	Total.
New York:																			
Iron mines.....									0	2				20	12	7	15	66	111
Other mines.....		28						0	0	5	2	2	6	15	2	5	3	64	34
Total.....		28						0		6	8	4	18	35	14	12	18	130	179
South Dakota.....	8	8	68	67	63	63	63	(c)	13	8	10	8	49	6	28	6	4	8	105
Tennessee:																			
Copper.....		1	3	3	1	1	0	3	0	1	1	0	0	7	2	8	5	28	44
Iron.....		0	0	2	2	0	0	0	0	0	0	0	0	2	0	0	0	2	8
Other metals.....		0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2	2
Total.....		1	4	5	3	1	0	3	0	1	1	0	0	9	3	8	5	32	54
Grand total.....	99	162	297	245	251	288	331	314	285	317	317	362	458	453	325	430	423	427	5,764

a Fay, A. H., Metal-mine accidents in the United States during the calendar year 1911: Technical Paper 40, Bureau of Mines, 1913.

b Includes some quarry accidents.

c Figures unavailable.

d Two accidents listed as nonfatal terminated fatally, making a total of 9 instead of 7 as given in the official total.

e Detailed list shows 8 deaths instead of 6 deaths as given in official total.

TABLE 9.—Number of men killed per 1,000 employed in and about the metal and nonmetal (except coal) mines of the United States, a 1894-1911.

State.	1894	1895	1896	1897	1898	1899	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	Average.
Colorado ^b																			
Idaho.....			4.03	3.77	3.57	2.63	2.67	3.25	2.34	2.08	2.86	3.18	2.36	2.23	1.96	2.51	2.61	2.77	2.79
Michigan:																			2.51
Dickinson County, iron mines.....																			
Gogebic County iron mines.....	3.62	3.02	5.57	4.02	4.78	3.13	5.01	7.70	2.54	4.00	2.95	2.80	4.30	2.06	1.64	0.76	2.90	1.12	3.56
Iron County iron mines.....	2.15	4.76	5.89	4.75	(d)	2.83	3.53	5.34	7.09	3.84	4.76	4.85	8.26	4.70	3.97	4.14	6.08	5.35	e 5.03
Marquette County iron mines.....	4.28	3.39	5.38	4.01	4.33	4.60	3.62	5.58	8.97	11.32	14.72	11.36	7.63	10.12	4.87	6.30	4.93	4.28	7.55
Average for iron mines.....	3.64	3.69	5.57	44.28	94.37	3.76	4.23	6.30	5.43	4.66	4.62	4.88	5.61	5.26	3.35	3.88	4.72	4.55	4.70
Houghton County copper mines.....	3.00	6.35	2.33	2.98	2.20	2.07	2.65	2.44	3.11	2.42	3.14	3.74	2.54	2.96	3.42	3.51	3.51	3.25	3.05
Keweenaw County copper mines.....	(d)	(d)	(d)	(d)	(d)	(d)	(d)	(d)	(d)	(d)	(d)	(d)	(d)	(d)	(d)	1.44	1.74	2.80	1.64
Average for iron and copper mines.....	43.30	64.91	64.10	64.06	63.05	62.87	63.65	64.37	64.31	63.63	63.79	64.27	64.03	64.10	63.39	63.51	63.99	63.69	63.83
Minnesota:																			
St. Louis County iron mines.....																			
Itasca County iron mines.....						5.02	5.24	5.10	(d)	6.26	2.76	(d)	7.25	5.03	3.91	4.57	4.03	3.92	4.74
Average.....																4.86	3.92	2.29	3.58
Missouri ^b																			
Montana.....	3.36	4.52	2.09	2.51	5.02	5.24	5.10	5.10	(d)	6.26	2.76	(d)	7.25	5.03	3.91	4.61	4.01	3.80	4.67
Nevada.....	83.81	3.48	8.26	5.07	4.80	4.80	3.53	3.73	1.32	1.29	2.20	3.63	4.46	2.85	2.97	3.85	3.23	2.70	3.11
New York:																			
Iron mines.....		82.35							0.00	1.26	8.36	1.29	6.70	7.51	9.48	3.71	7.46	m 3.22	5.00
Other mines ^a									0.00	0.00	4.52	3.06	6.89	14.76	2.58	4.84	2.92	m 2.90	4.68
Average.....			12.41	11.75	10.64	10.50	10.54	0.00	0.89	6.51	6.89	1.82	6.76	9.51	6.80	4.11	5.45	m 3.12	3.59

^a Figures include only those States having mine-inspection service.

^b Figures include mill and smelting-plant accidents.

^c Great Britain, Part IV, Mines and Quarries, General Report and Statistics, 1898.

^d Figures not available.

^e Omitting years 1897 and 1898, for which figures are not available.

^f Includes some quarry accidents.

^g Omitting Gogebic County.

^h Excluding Keweenaw County, statistics for which are unavailable.

ⁱ Based on nine months' figures only.

^j Includes some fatalities in coal mines.

^k Based on figures of men employed, reported in Metal-mines accidents in the United States during the calendar year 1911, by A. H. Fay, Technical Paper 40, Bureau of Mines, 1913.

^m Includes tale and gypsum tail accidents.

TABLE 9. — *Number of men killed per 1,000 employed in and about the metal and nonmetal (except coal) mines of the United States, 1894-1911—Continued.*

State.	1894	1895	1896	1897	1898	1899	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	Average.
South Dakota.....	6.25							(a)	4.37	2.39	2.86	2.26	2.25	2.71	2.25	1.83	1.20	2.01	d 2.49
Tennessee:																			
Copper mines.....	(b)	20.00	(b)	3.88	5.41	0.00	3.39	0.00	0.00	1.01	1.64	0.00	0.00	9.42	2.60	10.99	6.31	210.55	4.36
Iron mines.....	0.00	0.00	(b)	1.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.87	0.00	0.00	0.00	22.01	0.36
Average for iron and copper mines.....	(b)	(b)	(b)	1.94	1.24	0.00	1.17	0.00	0.00	0.39	0.54	0.00	0.00	3.05	0.86	3.40	2.48	65.70	1.61
Other mines.....	0.00	(b)	(b)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.37	0.00	0.00	0.00	0.06
Average for all mines.....	(b)	(b)	(b)	(b)	(b)	0.00	0.50	0.00	0.00	0.20	0.25	0.00	0.00	1.34	0.60	1.78	1.35	22.51	0.80
Grand average.....	3.58	5.91	4.30	3.57	3.47	2.19	3.08	3.36	2.85	2.82	2.88	3.44	3.62	3.42	2.64	3.41	3.34	3.46	3.28

a Figures not available.

b No employment figures given from which death rate can be calculated.

c Hoffman, F. L., Fatal accidents in American metal mines; Bull. 28, Min. and Met. Soc. of America, 1910, pp. 345-400.

d Omitting years 1897, 1898, 1903, and 1907, for which no employment figures were given.

e Based on employment figures in Report of chief inspector of mines of Tennessee for 1911.

TABLE 10.—*Number of men employed and number of men killed per 1,000 employed in and about all metal and miscellaneous mineral (except coal) mines of the United States for the calendar year 1911.^a*

	Total number employed.	Number of deaths.	Death rate per 1,000 men em- ployed.
Copper mines.....	44,693	238	5.33
Iron mines.....	45,953	197	4.29
Lead and zinc mines (Mississippi valley).....	12,521	43	3.43
Gold and miscellaneous metal mines.....	48,919	193	3.95
Miscellaneous mineral mines.....	13,893	24	1.73
Total.....	165,979	695	4.19

^a Fay, A. H., Metal-mine accidents in the United States during the calendar year 1911, Technical Paper 40. Bureau of Mines, 1913.

TABLE 11.—Number of men killed in and about the metal and nonmetal (except coal) mines of British North America, 1894-1911.

Provinces.	1894	1895	1896	1897	1898	1899	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	Total.
British Columbia.....					6	17	13	15	13	17	14	14	17	20	19	15	13	17	219
Newfoundland:																			
Copper.....							3	0	1	4	2	0	2	1	0	0	1	.....	14
Iron ore.....							0	1	4	1	1	3	1	6	9	1	2	.....	29
Iron pyrites.....							0	0	1	1	0	3	0	1	0	0	0	.....	6
Total.....							3	1	6	6	3	6	3	8	9	1	3	.....	59
Nova Scotia (gold).....	0	1	2	1	4	0	0	1	1	0	0	1	6	2	0	0	1	1	21
Ontario:																			
Copper and nickel.....	1	0	1	0	2	4	7	9	7	2	1	6	4	4	14	13	12	15	105
Gold.....	3	2	2	1	2	10	10	0	0	2	6	0	0	0	3	1	0	6	48
Iron.....	0	0	0	0	0	0	0	3	3	3	0	0	3	0	1	4	3	5	25
Silver and cobalt.....	0	0	0	0	1	0	0	0	0	0	0	0	2	15	25	28	26	15	113
Total, all mines.....	7	2	3	1	5	14	17	13	10	7	7	9	11	22	48	49	647	45	317
Quebec.....	0	0	0	0	8	0	2	7	2	1	4	2	7	9	7	13	10	3	75
Grand total.....	7	3	5	2	23	31	35	37	32	31	18	32	44	61	88	78	71	66	672

^a Only 47 officially reported, but detailed list shows 15.^b One accident in quarry omitted.^c Not stated.

TABLE 12.—Number of men killed per 1,000 employed in and about the metal and nonmetal (except coal) mines of British North America, 1894-1911.

Provinces.	1894	1895	1896	1897	1898	1899	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	Average.
British Columbia a.....					63.00		3.50	3.47	3.53	6.18	4.04	3.77	4.27	5.07	5.01	4.61	3.51	4.73	44.25
Newfoundland:																			
Copper.....							7.46	0.00	2.23	6.41	3.51	0.00	4.44	3.13	0.00	0.00	1.90	.....	2.65
Iron ore.....							0.00	1.05	5.06	1.18	0.88	2.62	0.73	3.47	6.04	40.65	1.20	.....	2.07
Iron pyrites.....							0.00	0.00	4.44	4.00	0.00	13.04	0.00	10.53	0.00	0.00	0.00	.....	4.03
Average.....							2.37	0.76	4.10	3.49	1.51	3.08	1.48	3.73	4.96	40.50	1.41	.....	2.41
Nova Scotia (gold).....	0.00	1.93	3.78	1.42	7.50	0.00	0.00	1.13	1.31	0.00	0.00	1.99	13.54	4.00	0.00	0.00	2.50	3.33	2.17
Ontario:																			
Copper and nickel.....	6.11	0.00	2.06	0.00	3.14	4.77	4.85	3.94	4.84	1.57	0.94	5.10	2.82	2.19	8.13	7.24	5.43	6.15	4.43
Gold.....	32.61	8.44	10.38	2.28	3.45	15.08	13.33	0.00	0.00	4.06	26.09	0.00	0.00	0.00	8.66	10.00	0.00	10.05	6.82
Iron.....			0.00	0.00	0.00	0.00	0.00	8.33	7.73	9.26	0.00	0.00	14.71	0.00	2.73	10.23	5.35	7.30	5.10
Silver and cobalt.....					16.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.89	7.36	10.77	8.61	7.84	4.22	6.86
Average, all mines.....	8.94	2.76	3.69	0.87	3.16	6.92	5.01	3.50	2.24	2.05	1.97	1.70	2.16	3.51	6.41	5.78	4.87	3.96	3.98
Quebec.....					3.81	(e)	0.81	2.51	0.74	0.41	1.42	0.72	2.38	2.64	1.42	3.63	2.26	0.81	1.71
Grand average.....	5.87	2.42	3.65	1.08	5.21	7.65	3.07	2.83	2.44	2.85	2.29	2.25	3.02	3.50	4.48	4.38	3.63	3.42	3.35

a Based on figures of those employed both in producing and nonproducing mines.

b Based on estimated number of men employed.

c Based on estimated number of men employed.

d Period 1900-1911 only.

e Accident figures not reported.

which is stated to have been several hundred less than previous year, owing to labor troubles.

TABLE 13.—*Number of men killed in and about the principal metal and nonmetal (except coal) mines of Great Britain and certain British colonies, 1894-1911.*

Country or colony.	1894	1895	1896	1897	1898	1899	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	Total.
Great Britain:																			
Metal mines <i>a</i>				49	33	56	38	30	29	25	35	46	36	34	37	40	43	43	574
Iron mines <i>b</i>	30	21	20	40	18	43	25	23	19	23	17	21	25	23	16	21	19	27	431
Other mines.....	36	55	38	36	36	43	32	33	29	26	39	46	37	40	44	48	45	49	712
Total.....	66	76	58	76	54	86	57	56	48	49	55	67	62	63	60	69	64	76	1,143
Australasia:																			
New South Wales—																			
Gold, placer mines.....	7	7	8	8	0	7	2	6	4	1	4	2	1	3	0	1	2	0	63
Gold, lode mines.....	12	5	14	7	10	11	9	5	1	6	7	8	3	2	4	3	2	1	110
Total for all gold mines.....	19	12	22	15	10	18	11	11	5	7	11	10	4	5	4	4	4	1	173
Copper mines.....	0	1	1	2	5	4	5	3	0	2	3	1	3	1	6	4	7	10	58
Silver mines.....	9	20	12	e14	e19	e15	e28	e23	e12	d14	d14	d20	d19	d18	d19	d11	d17	23	305
Other mines.....	0	3	0	4	1	2	0	1	2	0	1	1	3	0	3	1	1	1	24
Total for all mines.....	28	36	35	35	35	39	42	38	19	23	29	32	29	24	32	20	29	35	560
New Zealand—																			
Gold, placer mines.....	0	1	0	5	12	16	8	8	12	10	9	13	7	4	5	5	2	3	120
Gold, lode mines.....	2	0	4	14	9	5	4	6	2	9	6	8	6	1	1	8	9	3	97
Total for all gold mines.....	2	1	4	19	21	21	12	14	14	19	15	21	13	5	6	13	11	6	217
Queensland—																			
Gold mines.....	14	.....	18	16	18	18	17	16	13	18	26	16	15	9	e27	e23	e12	.....	275
Other metal mines.....	0	.....	0	0	1	0	1	4	3	9	4	7	9	6	3	5	6	.....	58
Total.....	14	15	18	16	19	18	18	20	16	27	30	23	24	15	30	28	18	13	362
Victoria, gold mines.....	50	47	38	37	44	41	35	28	33	21	17	20	25	27	19	15	12	19	528
Western Australia, gold, lode mines.....	.....	9	18	27	31	44	45	45	30	41	41	34	39	41	40	33	27	36	590
Total for five provinces.....	94	108	113	134	150	163	152	145	121	131	132	130	130	112	127	109	97	109	2,255
Cape Colony, Kimberley diamond mines.....																			
Ceylon <i>f</i>	55	36	46	34	52	65	21	36	45	26	32	64	65	69	26	24	32	.....	728
Gold Coast, gold mines.....	19	.....	12	14	25	13	.....	.....	7	.....	18	20	17	24	16	10	20	25	229
					1	.....	.....	.....	.....	15	14	27	73	42	42	59	36	.....	309

TABLE 14.—*Number of men killed per 1,000 employed in and about the principal metal and nonmetal (except coal) mines of Great Britain and certain British colonies, 1894-1911.*

Country or colony.	1894	1895	1896	1897	1898	1899	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	Average.
Great Britain:																			
Metal mines ^a				1.46	0.96	1.59	1.10	0.92	0.94	0.84	1.19	1.58	1.19	1.08	1.24	1.41	1.50	1.48	1.23
Iron mines ^b	1.94	1.31	1.19	2.32	1.07	2.50	1.50	1.39	1.15	1.51	1.12	1.29	1.48	1.31	0.89	1.14	1.03	1.42	1.42
Other mines.....	1.18	1.82	1.23	1.20	1.19	1.36	1.04	1.10	1.03	0.94	1.37	1.65	1.29	1.35	1.60	1.82	1.63	1.80	1.56
Average for all mines.....	1.43	1.64	1.21	1.61	1.14	1.76	1.20	1.20	1.07	1.14	1.29	1.52	1.36	1.34	1.32	1.51	1.41	1.64	1.38
Australia:																			
New South Wales—																			
Gold, placer mines.....	0.80	0.62	0.80	0.89	0.00	0.87	0.24	1.11	0.74	0.17	0.76	0.39	0.24	0.92	0.00	0.42	0.85	0.00	0.59
Gold, lode mines.....	1.42	0.50	1.16	0.57	0.86	0.97	0.94	0.75	0.19	1.12	1.30	1.53	0.66	0.47	1.14	0.94	0.69	0.36	0.89
Total for all gold mines.....	1.11	0.56	1.00	0.70	0.50	0.93	0.51	0.91	0.47	0.62	1.03	0.97	0.45	0.67	0.63	0.72	0.76	0.22	0.75
Copper mines.....	0.00	1.15	1.23	1.17	2.53	1.69	1.50	1.04	0.60	1.10	1.62	0.46	0.98	0.27	2.19	1.98	3.06	4.65	1.72
Silver mines.....	2.14	4.29	2.16	e2.26	e2.97	e1.90	e3.17	e3.65	e2.32	e2.32	e1.98	e2.54	e2.02	e1.80	e2.51	e1.77	e2.13	2.71	2.15
Other mines.....	0.00	1.53	0.00	1.57	0.50	0.76	0.00	0.35	0.69	0.00	0.24	0.23	0.49	0.00	0.71	0.25	0.26	0.25	0.39
Average for all mines.....	1.16	1.25	1.15	1.12	1.16	1.21	1.30	1.57	0.92	0.98	1.22	1.29	1.06	0.72	1.53	1.12	1.50	1.81	1.22
New Zealand—																			
Gold, placer mines.....	0.00	0.11	0.00	0.55	1.34	1.85	0.87	0.98	1.58	1.51	1.47	2.24	1.45	0.74	1.10	1.33	0.53	0.93	0.98
Gold, lode mines.....	0.35	0.00	0.34	2.55	1.91	1.07	0.94	1.31	0.52	2.50	1.26	2.23	1.62	0.27	2.24	2.15	2.08	0.73	1.35
Average for all gold mines.....	0.17	0.09	0.30	1.34	1.54	1.58	0.89	1.11	1.23	1.86	1.38	2.24	1.52	0.55	0.69	1.73	1.36	0.81	1.11
Queenland—																			
Gold mines.....	1.23		1.74	1.25	1.60	1.84	1.67	1.70	1.44	1.95	2.70	1.50	1.52	1.13	3.51	3.22	1.96		1.81
Other metal mines.....	0.00		0.00	0.00	1.14	0.00	0.46	1.51	1.17	2.36	0.90	1.27	1.29	0.76	0.46	0.96	0.96		0.92
Total for metal mines.....	1.02	1.14	1.56	1.08	1.57	1.42	1.46	1.65	1.38	2.04	2.13	1.42	1.43	0.95	2.12	2.26	1.46	1.16	1.51
Victoria, gold mines.....	1.79	1.57	1.18	1.13	1.13	1.36	1.21	1.01	1.26	0.83	0.70	0.79	0.99	1.16	0.91	0.80	0.73	1.35	1.17
Western Australia, gold mines.....		0.42	0.89	1.51	2.37	2.74	2.69	2.68	2.19	2.37	2.44	2.02	2.35	2.56	2.64	2.06	1.75	2.43	2.00
Average for five provinces.....	1.22	1.63	1.04	1.22	1.50	1.35	1.46	1.55	1.38	1.47	1.47	1.41	1.37	1.23	1.59	1.51	1.35	1.83	1.38
Cape Colony, Kimberley diamond mines.....	7.34	3.78	4.73	3.27	4.23	5.15	2.28	3.21	3.73	2.66	2.26	3.50	2.72	3.17	2.19	1.63	1.82		3.17
Ceylon.....	1.91			0.49		0.49	0.17		0.18									1.51	0.34
Gold coast, gold mines.....					0.34					2.21	0.82	2.08	5.16	2.76	2.66	3.71	1.88		2.58

India:

Gold mines <i>a</i>	4.44	2.12	2.56	2.95	2.12	2.48	1.50	2.35	2.17	1.94	3.27	3.54	2.52	.....	2.38
Mica mines.....	0.32	20.27	0.84	1.95	0.21	0.39	0.88	0.25	0.62	0.72	0.20	0.71	0.37	0.64	0.53
Average for gold and mica mines.....	1.33	1.53	2.09	2.68	1.64	2.12	1.31	1.68	1.68	1.54	2.30	2.90	1.86	0.64	1.89
Transvaal, gold mines only <i>d</i>	4.44	4.35	(<i>j</i>)	(<i>j</i>)	4.78	5.32	4.35	5.36	5.40	4.94	4.20	5.61	4.53	4.33	4.77
Grand average.....	2.73	2.42	2.76	2.20	1.72	2.50	2.09	2.86	2.91	2.62	2.56	3.11	2.79	3.24	2.50

a Figures cover all mines included under the Metalliferous Mines Regulation Act.

b Figures do not include open-pit mines.

c Includes lead mines.

d Includes lead and zinc mines.

e Does not include open workings.

f Based on incomplete employment figures.

g Includes figures for Mysore gold mines.

h Returns incomplete.

i Figures for calendar year instead of statistical year.

j Figures not available on account of war.

TABLE 15.—Number of men killed in and about the principal metal and nonmetal (except coal) mines of various foreign countries, 1894-1911.

Countries.	1894	1895	1896	1897	1898	1899	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	Total.
Austria:																			
Iron mines.....		8	8	6		9		8	12	2	6	6	5	9	9	7	2		97
Other mines.....			15	10		9		10	7				11	8	1	9	11		120
Total.....		16	23	16		18		18	19	8	12	17	14	17	10	16	13		217
Belgium, iron mines.....	3	1	0	2	0	1	1	2	0	1	0	1	1	0	0	0	1		14
France.....	10	15	20	27	37	28	30	29	17	45	41	28	51	55	51	73	86		643
Greece <i>a</i>	9				7	3		9		13	13	13	17	23	9	13	9		138
Italy <i>b</i>	68	69	75	123	82	107	119	126	86	110	120	114	69	113	73	69	59		1,582
Japan:																			
Metal mines.....									177	85	68	70	193	106	65	97	103		964
Nonmetal mines <i>c</i>									16	9	10	4	10	7	5	41	15		117
Total.....									193	94	78	74	203	113	70	138	118		1,081
Portugal.....						7		9	4	4	2	2	2	10	9	11	11		71
Prussia:																			
Ore mines.....	62	63	72	68	65	94	78	81	60	68	61	76	76	107	74	52	81		1,238
Other mines.....	21	23	21	23	(<i>d</i>)	20	27	50	31	29	35	31	43	48	41	39	60		542
Total.....	83	86	93	91	65	114	105	131	91	97	96	107	119	155	115	91	141		1,780
Russia:																			
Gold and platinum mines.....								35	55	53	50	53	48	74	48				416
Other mines.....								103	71	83	89	93	85	81	130				755
Total.....								138	126	136	139	146	133	155	178				1,151
Saxony, ore mines.....						4	4	3	5	1	1	2	2	2	6	1	1		40
Grand total.....	173	187	211	264	194	282	259	465	541	509	502	504	611	643	521	412	439		6,717

a Figures do not include quarries.*b* Figures do not include salt works, quarries, or turbaries.*c* Figures do not include coal mines.*d* Not stated.

TABLE 16.—Number of men killed per 1,000 employed in and about the principal metal and nonmetal (except coal) mines of various foreign countries, 1894-1911.

Countries.	1894	1895	1896	1897	1898	1899	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	Average.
Austria:																			
Iron mines.....	1.78	1.66	1.14	1.14	1.68	1.68	1.36	1.36	2.24	0.45	1.41	1.25	0.96	1.71	1.66	1.29	0.36	.....	1.35
Other mines.....	1.15	0.77	0.62	0.62	0.68	0.68	0.78	0.78	0.55	0.49	0.50	0.90	0.76	0.67	0.09	0.83	1.04	.....	0.70
Total.....	1.16	1.29	0.88	0.88	0.97	0.97	0.97	0.97	1.06	0.47	0.74	1.00	0.82	0.99	0.59	0.99	0.80	.....	0.90
Belgium, ore mines.....	1.36	0.45	0.00	1.03	0.00	0.67	0.70	1.67	0.00	1.05	0.00	1.43	1.15	0.00	0.00	0.00	0.75	.....	0.66
France.....	0.81	1.33	1.67	2.06	2.75	1.75	1.79	1.78	1.07	2.73	2.34	1.53	2.47	2.27	2.11	2.99	3.16	.....	2.14
Greece.....	1.48	.....	.....	.....	0.77	0.32	0.95	0.95	1.98	1.31	1.31	1.55	1.96	1.96	0.88	1.55	1.30	.....	1.23
Italy.....	1.31	1.60	1.62	2.30	1.42	1.66	1.76	1.80	1.35	1.75	1.92	1.78	1.10	1.90	1.29	1.31	1.18	.....	1.60
Japan:																			
Metal mines.....	.....	.....	.....	.....	.....	.....	.....	.....	2.93	1.31	0.98	1.01	2.62	1.38	0.94	1.31	1.38	.....	1.32
Nonmetal mines.....	.....	.....	.....	.....	.....	.....	.....	.....	2.08	1.23	1.35	0.59	1.32	0.78	0.81	5.69	1.50	.....	1.09
Total.....	.....	.....	.....	.....	.....	.....	.....	.....	2.84	1.30	1.02	0.97	2.50	1.32	0.93	1.70	1.39	.....	1.73
Portugal:																			
Total.....	.....	.....	.....	.....	.....	.....	.....	.....	1.06	0.96	0.57	0.44	0.43	2.55	1.29	1.40	1.68	.....	1.31
Prussia:																			
Ore mines.....	1.01	1.00	1.14	1.05	0.99	1.39	1.12	1.17	0.90	1.03	0.91	1.11	1.09	1.50	1.08	0.78	1.25	.....	1.09
Other mines.....	1.77	1.92	1.65	1.61	.....	1.23	1.54	2.73	1.68	1.50	1.64	1.34	1.70	1.76	1.45	1.41	2.07	.....	1.68
Total.....	1.13	1.15	1.22	1.15	.....	1.36	1.20	1.50	1.07	1.14	1.09	1.17	1.25	1.58	1.18	0.97	1.51	.....	1.22
Russia:																			
Gold and platinum mines.....	.....	.....	.....	.....	.....	.....	.....	0.39	0.62	0.59	0.62	0.69	0.65	1.01	0.59	.....	.....	.....	0.64
Other mines.....	.....	.....	.....	.....	.....	.....	.....	1.57	1.09	1.51	1.72	1.69	1.42	1.27	2.19	.....	.....	.....	1.55
Total.....	.....	.....	.....	.....	.....	.....	.....	0.89	0.82	0.96	1.05	1.11	0.99	1.15	1.26	.....	.....	.....	1.02
Saxony, ore mines.....	0.66	.....	0.36	0.97	0.65	0.95	1.04	0.79	1.40	0.30	0.32	0.77	0.76	0.80	2.53	0.46	0.52	.....	a 0.87
Grand total.....	1.18	1.26	1.37	1.54	1.28	1.40	1.39	1.32	1.31	1.22	1.22	1.21	1.42	1.46	1.21	1.43	1.53	.....	1.33

a Based on totals from 1897 to 1900, inclusive.

TABLE 17.—Number of men injured in and about the metal and nonmetal (except coal) mines of the United States, a 1894-1911.

State.	1894	1895	1896	1897	1898	1899	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	Total.
Colorado ^b				107	184	481	526	623	567	494	549	486	336	300	313	347	271	247	6,013
Michigan:																			
Houghton County copper mines.....	14	17	8	6	8	14	15	22	14	13	13	7	9	3	6	67	5	(d)	181
Dickinson County iron mine.....	1	17	5	7	19	17	12	8	18	17	18	12	12	15	6	17	10	19	239
Total.....	15	34	13	13	27	31	27	43	36	32	33	19	21	18	12	24	15	19	411
Minnesota:																			
St. Louis County iron mines.....					208	6387	117	(d)	(d)	632	99	(d)	50	66	54	62	90	91	1,069
Haven County iron mines.....																259	206	224	639
Total.....					208	6387	117	(d)	(d)	632	99	(d)	50	66	54	62	90	91	1,069
Missouri ^h					208	387	17	(d)	(d)	32	9	(d)	50	66	54	321	206	318	1,758
Montana.....	29	32	19	5	16	19	23	24	22	21	8	14	31	22	473	15	32	17	422
New York.....	119	419	121	21	29	122	28	32	45	50	55	39	42	22	16	30	30	18	538
South Dakota.....	5	(d)	(d)	7	(d)	(d)	(d)	(d)	9	9	112	m 8	n 11	3	a 20	7	55	(d)	91
Grand total.....	68	85	160	215	464	910	621	719	675	636	664	566	491	431	488	797	600	670	9,350

^a Figures include only those States having mine-inspection service.^b Figures include mill and smelting-plant accidents.^c Detailed list shows 7 nonfatal accidents, but official total list shows only 4.^d Figures unavailable.^e 316 were minor accidents.^f Total for 9 months only; does not include accidents reported by inspector, but only those reported to the Commissioner of Labor.^g Incomplete.^h Figures cover lead with zinc mines only, but include mill and smelting-plant accidents.ⁱ Detailed list shows 73, but official list reports 54.^j Includes coal-mining accidents.^k Total for eight months only; mine-inspection law went into effect on April 1, 1909.^l Detailed list shows 12, but official list reports only 10.^m Detailed list shows 8, but official list reports 6.ⁿ Detailed list shows 13, but official list reports 14.^o Detailed list shows 20, but official list reports 16.

TABLE 18.—Number of men injured per 1,000 employed in and about the metal and nonmetal (except coal) mines of the United States, a 1894-1911.

State.	1894	1895	1896	1897	1898	1899	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	Average.
Colorado ^b			4.19	5.78	6.09	12.27	13.11	10.99	16.15	15.31	15.52	14.17	9.66	9.09	9.57	17.09	14.00	15.91	12.16
Michigan:																			
Houghton County copper mines.....	1.91	2.35	0.98	0.69	0.76	1.07	1.07	1.63	0.99	0.95	0.91	0.46	0.55	0.11	0.35	0.39	0.31	(c)	d 0.80
Dickinson County iron mines.....	0.59	8.57	1.99	3.24	7.69	5.97	3.73	2.31	4.57	4.25	5.91	3.74	3.45	4.42	2.86	6.42	3.22	7.08	4.39
Minnesota:																			
St. Louis County iron mines.....					57.98	59.67	f 2.99	(c)	(c)	3.88	1.24	(c)	3.89	4.24	4.06	4.64	5.11	4.72	8.63
Itasca County iron mines.....																114.35	67.21	73.20	82.12
Total.....																			
Missouri ^g	5.73	6.29	3.06	0.79	57.98	59.67	2.99	(c)	(c)	3.88	1.24	(c)	3.89	4.24	4.06	20.54	14.31	13.84	13.30
Montana.....	13.58	2.89	13.89	2.80	2.10	1.73	1.99	2.18	1.94	1.70	0.55	1.12	2.34	1.46	1.47	0.90	2.35	1.35	2.21
Nevada.....					3.31	42.24	2.49	2.65	3.25	3.53	3.80	2.66	2.80	1.47	1.10	2.00	2.07	1.24	2.53
South Dakota.....	3.90	(c)	(c)	(j)	(j)	(c)	(c)	(c)	3.91	(c)	3.43	2.26	2.75	(c)	5.62	2.13	3.90	6.12	7.72
Grand total.....	3.17	4.07	3.35	3.86	7.35	11.23	7.24	9.30	8.28	7.40	7.25	6.78	4.92	4.30	4.92	8.22	7.25	7.14	6.85

^a Figures include only those States having mine-inspection service.^b Figures include mill and smelting-plant accidents.^c Figures unavailable.^d Excluding 1911.^e Includes both serious and slight accidents.^f Total for 9 months only; returns incomplete.^g Figures cover lead and zinc mines only, but include mill and smelting-plant accidents.^h Based on estimated number of men employed.ⁱ Includes coal-mine accidents.^j Can not be stated, as no employment figures are given.

TABLE 19.—*Number of men injured in and about the metal and nonmetal (except coal) mines of British North America, 1894-1911.*

Provinces.	1894	1895	1896	1897	1898	1899	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	Total.
British Columbia.....					1	29	37	36	52	17	31	18	43	74	25	10	25	33	431
Nova Scotia, gold mines.....					1	3	(a)	1	3	0	0	0	2	2	0	0	1	1	14
Ontario:																			
Copper and nickel mines.....	4	5	2	4	3	7	4	15	5	8	5	5	2	3	4	2	6	14	98
Gold mines.....	3	9	0	17	7	5	5	4	6	5	0	0	0	0	3	0	4	8	76
Iron mines.....			0	0	0	1	1	13	1	3	0	0	12	7	19	8	17	25	107
Silver and cobalt mines.....						0	0	0	0	0	0	0	3	9	13	35	29	34	123
Total for all Ontario mines.....	7	14	2	21	10	13	14	32	12	16	5	10	18	19	41	53	65	110	462
Quebec.....					2	(a)	(a)	3	4	2	4	2	5	5	5	12	141	103	288
Grand total.....	7	14	2	21	14	45	71	72	71	35	40	30	68	100	71	75	232	247	1,195

^a Not stated.^b Detailed list shows 13, whereas official total gives 11 only.^c Detailed list shows 41 instead of 40 as officially reported.TABLE 20.—*Number of men injured per 1,000 employed in and about the metal and nonmetal (except coal) mines of British North America, 1894-1911.*

Provinces.	1894	1895	1896	1897	1898	1899	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	Average.
British Columbia.....					a 0.50	b 0.33	9.90	8.33	14.10	6.18	8.94	4.85	10.80	18.77	6.59	3.73	6.74	9.18	c 9.12
Nova Scotia, gold mines.....					1.88	5.67	.....	1.13	3.94	0.00	0.00	0.00	3.87	4.00	0.00	0.00	2.50	3.33	c 2.01
Ontario:																			
Copper and nickel mines.....	6.11	11.26	4.12	7.48	4.71	8.34	2.77	6.57	3.46	6.26	4.70	4.25	1.41	1.69	2.32	1.11	2.71	5.74	4.12
Gold mines.....	32.61	37.97	0.00	38.81	12.07	7.33	6.67	6.84	8.27	10.14	0.00	0.00	0.00	0.00	8.38	0.00	12.54	13.40	10.80
Iron mines.....			0.00	0.00	0.00	11.49	2.28	36.11	2.58	9.26	0.00	0.00	58.82	25.36	51.91	20.46	30.30	36.50	21.81
Silver and cobalt mines.....					0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.84	4.42	5.39	10.70	8.74	9.56	7.47
Total for all Ontario mines.....	8.94	19.42	2.46	18.29	6.33	6.49	4.13	8.62	2.67	4.68	1.41	1.89	3.33	3.03	5.47	6.25	6.74	9.37	5.82
Quebec.....					0.95	.....	.....	1.07	1.47	0.83	1.42	0.72	1.70	1.47	1.04	3.35	31.88	27.94	6.35
Grand average.....	8.94	19.42	2.46	18.29	2.24	11.11	9.96	6.15	6.11	3.82	3.90	2.47	5.55	7.08	4.25	4.74	12.33	12.79	6.93

^a Based on estimated number of men employed.^b Based on estimated number of men employed, which is stated to have been several hundred less than previous year owing to labor trouble.^c Based on figures for 1900-1911 only.

TABLE 21.—Number of men injured in and about the principal metal and nonmetal (except coal) mines of Great Britain, British colonies, and other foreign countries, 1894–1911.

Countries and colonies.	1894	1895	1896	1897	1898	1899	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	Total.
Great Britain, metal mines ^a.....	.....	.....	.....	308	335	362	294	257	254	266	246	265	223	307	1,407	1,434	1,596	1,744	9,298
Australasia:																			
New South Wales—																			
Gold, placer mines.....	1	5	4	4	3	1	0	2	3	3	9	2	3	2	1	1	2	0	46
Gold, lode mines.....	41	11	24	18	16	34	37	11	11	17	20	17	14	10	16	9	5	6	317
Total for all gold mines.....	42	16	28	22	19	35	37	13	14	20	29	19	17	12	17	10	7	6	363
Copper mines.....	1	2	9	8	16	21	22	7	12	18	17	14	13	24	19	14	9	5	231
Silver mines.....	19	37	49	47	74	94	133	55	26	56	65	28	34	63	61	67	20	6	825
Other mines.....	0	0	2	0	2	3	7	0	2	0	0	1	1	0	1	2	0	1	22
Total.....	62	55	88	77	111	153	199	75	54	94	111	62	65	69	55	43	36	32	1,441
New Zealand—																			
Gold, placer mines.....	0	0	(c)	4	2	3	5	10	13	17	11	7	3	3	2	2	2	7	91
Gold, lode mines.....	9	16	(c)	24	26	29	14	31	21	d 28	7	6	2	1	3	5	15	16	253
Total for gold mines.....	9	16	(c)	28	28	32	19	41	34	45	18	13	5	4	5	7	17	23	344
Queensland ^e	105	105	97	65	86	80	91	101	89	100	95	91	133	102	111	105	132	401	2,089
Victoria, gold mines.....	83	82	99	91	98	87	87	98	77	86	93	81	99	91	87	99	66	65	1,571
Western Australia, gold, lode mines.....	.....	(c)	59	71	77	96	131	123	124	167	149	270	441	372	364	411	507	474	3,839
Total for five Provinces.....	259	258	343	332	400	450	527	438	378	492	466	517	746	638	622	665	758	995	9,284
Cape Colony, Kimberley diamond mines.....	39	56	91	112	200	160	70	180	201	209	238	278	335	303	145	166	269	.....	3,052
Austria:																			
Iron mines.....	.....	18	21	.....	.....	35	.....	47	31	34	23	41	58	50	59	22	36	.....	475
Other mines.....	.....	42	39	.....	.....	57	.....	67	71	82	82	82	83	108	82	83	77	.....	955
Total.....	.....	60	60	.....	.....	92	.....	114	102	116	105	123	141	158	141	105	113	.....	1,430
Italy ^f	164	123	160	143	171	175	166	183	163	188	166	159	73	190	105	100	125	.....	2,554

^a Figures cover all mines included under Metaliferous Mines Regulation Act.

^b Includes lead and zinc mines.

^c Not stated.

^d Only 26 deaths given in official total, but detailed list shows 28.

^e Metaliferous mines and mills.

^f Does not include salt works, quarries, or turbaries.

TABLE 22.—*Number of men injured per 1,000 employed in and about the principal metal and nonmetal (except coal) mines of Great Britain, British colonies, and other foreign countries, 1894-1911.*

Countries and colonies.	1894	1895	1896	1897	1898	1899	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	Average.
Great Britain, metal mines, <i>a</i>				9.19	9.79	10.30	8.53	7.92	8.24	8.92	8.34	9.09	7.38	9.72	47.03	50.44	56.96	60.10	19.87
Australia: New South Wales— Gold for all placer mines.....	0.11	0.44	0.40	0.44	0.36	0.12	0.00	0.37	0.55	0.51	1.71	0.39	0.71	0.62	0.35	0.42	0.85	0.60	0.43
Gold for all lode mines.....	1.84	1.09	1.99	1.47	1.38	3.02	3.87	1.65	2.13	3.18	3.71	3.26	3.07	2.37	4.36	2.84	1.73	2.13	2.55
Average for all gold mines.....	2.44	0.62	1.27	1.03	0.95	1.81	2.06	1.08	1.32	1.78	2.66	1.85	1.93	1.57	2.67	1.79	1.33	1.29	1.57
Copper mines.....	1.55	2.30	11.11	4.08	8.10	8.86	6.60	2.97	7.06	9.91	9.19	6.45	4.27	6.38	6.92	6.92	3.94	2.52	6.04
Silver mines.....	4.52	7.94	8.82	7.58	11.57	11.91	16.23	8.73	4.83	9.28	9.41	3.55	3.61	93.29	6.238	6.275	6.250	6.236	6.38
Other mines.....	0.00	0.00	0.99	0.00	0.99	1.12	2.53	0.00	0.69	0.00	0.00	0.23	0.16	0.00	0.24	0.50	0.00	0.35	0.36
Average.....	2.58	1.95	2.80	2.47	3.66	4.74	6.17	3.10	2.62	4.01	4.69	2.50	2.38	2.61	2.63	2.41	1.86	2.08	3.15
New Zealand— Gold, placer mines.....	0.00	0.00	(c)	0.44	0.22	0.35	0.54	1.23	1.71	2.57	1.79	1.21	0.62	0.56	0.44	0.53	0.53	2.17	0.80
Gold, lode mines.....	4.21	6.27	(c)	4.74	5.54	6.22	3.28	6.75	5.52	7.78	1.47	1.67	0.54	0.27	0.73	1.34	3.47	3.87	3.55
Average.....	0.78	1.40	.....	1.97	2.05	2.41	1.41	3.22	2.99	4.41	1.65	1.19	0.58	0.44	0.58	0.93	2.10	3.12	1.90
Queensland <i>b</i>	5.63	8.00	8.42	4.37	7.09	6.32	7.39	8.55	7.67	7.58	6.76	5.64	7.90	6.43	7.84	8.48	10.70	33.71	8.70
Victoria, gold.....	2.98	2.74	3.08	2.77	3.18	2.90	3.00	3.33	2.95	3.41	3.82	3.19	3.91	3.91	4.17	5.30	33.90	4.63	3.41
Western Australia, gold, lode mines.....	.....	2.92	3.97	3.40	.....	5.97	8.94	7.34	6.36	9.64	8.85	16.04	26.74	23.17	21.00	25.69	32.77	32.03	11.36
Total for five Provinces.....	3.35	2.46	3.19	3.22	4.00	4.31	5.08	4.08	4.32	5.50	5.19	5.59	7.88	7.04	7.80	9.19	10.56	14.90	5.79
Cape Colony, Kimberley diamond mines.....	3.20	3.89	9.35	10.76	16.29	12.63	7.59	16.03	16.68	16.92	16.81	15.19	14.03	13.92	12.24	11.28	13.31	.....	13.30
Austria: Iron mines.....	.....	4.00	4.35	.....	.....	6.68	.....	8.00	5.79	7.57	5.40	8.51	11.15	9.54	10.89	4.14	6.42	.....	7.16
Other mines.....	.....	3.25	3.00	.....	.....	4.33	.....	5.26	4.40	6.72	6.79	6.85	6.98	9.06	7.20	7.70	7.27	.....	6.65
Average.....	.....	3.45	3.36	.....	.....	4.97	.....	6.15	5.67	6.95	6.45	7.21	8.26	9.21	8.38	6.47	6.99	.....	6.56
Italy <i>c</i>	3.23	2.85	3.45	2.68	2.96	2.72	2.45	2.71	2.58	2.99	2.66	2.50	1.17	3.19	1.86	1.90	2.50	.....	2.59

a Metaliferous mines and mills.*c* Figures do not include salt works, quarries, or turbaries.*a* Figures cover all mines included under Metaliferous Mines Regulation Act.*b* Includes lead and zinc mines.*c* Number of injuries not reported.

TABLE 23.—Number of men employed in and about the metal and nonmetal (except coal) mines of the United States, a 1894-1911.

State.	1894	1895	1896	1897	1898	1899	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	Total.
Colorado b.....			25,545	29,215	30,231		40,111	37,260	35,118	32,267	35,376	34,287	34,790	33,014	32,726	20,302	19,568	15,565	494,519
Idaho.....										7,000	6,000	6,000	7,000	7,000	5,000	6,000	6,000	6,500	56,500
Michigan:																			
Dickinson County iron ore mines.....	1,687	1,984	2,515	2,161	2,470		3,213	3,467	3,943	4,004	3,048	3,212	3,489	3,392	2,445	2,649	3,104	2,683	52,339
Gogebie County iron ore mines.....	1,399	2,310	2,717	(c)	(c)		3,654	3,371	4,088	4,422	3,154	3,437	4,226	4,098	3,277	4,584	3,045	4,489	59,068
Iron County iron mines.....									1,360	1,078	815	1,409	1,268	2,470	2,538	3,045	2,802	21,397	
Marquette County iron mines.....	3,506	3,574	4,650	4,153	4,389	5,655	6,627	5,200	5,518	6,000	4,027	5,060	5,840	6,744	5,362	5,682	6,546	6,385	94,918
Total for iron mines.....	6,592	7,868	6,314	6,859	11,705		13,494	13,493	15,109	16,044	11,044	13,218	15,521	17,304	14,342	15,454	17,700	16,359	228,352
Houghton County copper mines.....	7,348	7,249	8,170	8,726	10,467	13,051	13,971	13,498	14,130	13,629	14,321	15,225	16,506	17,579	17,244	17,974	16,250	15,361	240,701
Keweenaw County copper mines.....																2,771	2,295	2,144	7,210
Total for iron and copper mines.....	13,940	15,117	18,052	15,040	17,328	24,756	27,465	26,991	29,239	29,733	25,365	28,343	33,027	34,883	31,586	33,436	33,953	31,503	476,263
Minnesota:																			
St. Louis County iron mines.....					3,587			e5,086	(c)	8,256	8,240	7,234	12,838	15,535	1,331	1,331	17,613	19,918	132,005
Itasca County iron mines.....																2,265	3,065	3,060	8,390
Total.....																			
Missouri f.....	5,065	5,087	6,214	6,364	7,009	3,587	6,486	5,086	(c)	8,256	8,240	7,234	12,838	15,535	1,331	1,331	20,678	22,978	140,456
Montana.....	47,082	6,574	47,747	7,488	8,759	9,816	11,246	12,078	13,784	14,175	14,480	14,680	15,000	15,000	15,000	15,000	14,500	14,500	206,469
Nevada.....																15,573	15,820	16,210	17,432
New York:																			
Iron mines.....	340							945	1,584	305	718	1,546	1,792	2,665	1,266	1,885	2,011	21,865	16,592
Other mines.....								705	656	617	443	653	871	1,016	1,775	1,094	1,291	11,337	9,398
Total.....	340	m3,322	m4,008	m4,674	m5,047	m5,595	1,650	(c)	2,250	922	1,161	2,199	2,663	3,681	2,041	2,919	3,302	43,202	49,876
South Dakota:	1,281	(c)	(c)	(c)	(c)	(c)	(c)	(c)	3,207	(c)	3,500	3,547	4,000	(c)	3,560	3,586	3,381	3,974	29,686
Tennessee:																			
Copper mines.....	(c)	150	(c)	258	185	750	886	909	446	986	611	503	628	743	708	728	793	758	10,102
Iron mines.....	(c)	(c)	(c)	1,291	624	1,465	1,682	1,223	1,625	1,580	1,230	1,407	1,989	2,307	1,559	1,626	1,503	996	22,007
Total for iron and copper mines.....	(c)	(c)	(c)	1,540	809	2,215	2,368	2,132	1,971	2,566	1,841	1,910	2,617	3,050	2,327	2,354	2,296	1,754	32,109
Other mines a.....	(c)	(c)	(c)	(c)	(c)	5,252	3,350	2,445	3,044	2,479	2,164	2,015	2,282	3,670	2,682	2,192	1,408	2,234	35,148
Total.....	150	150	150	1,540	809	7,467	5,918	4,577	5,015	5,045	4,005	3,925	4,899	6,720	5,010	4,486	3,704	3,978	67,257
Grand total.....	27,368	27,298	28,800	28,800	30,664	32,997	34,670	34,007	34,551	34,551	34,551	34,551	34,551	34,551	34,551	34,551	34,551	34,551	34,551

a Figures include only those States having mine-inspection service.

b Figures include persons employed in mills and smelters.

c Figures unavailable.

d Includes small number employed in quarries.

e Nine months' total only.

f Figures cover lead and zinc mines only, but include mill and smelting-plant accidents.

g Estimated total; no employment figures given for western district.

h Includes 1,782 men employed in coal mines.

i Includes 2,355 men employed in coal mines.

j Census Bulletin on Mines and Quarries, Washington, 1910.

k Estimated total figured on basis of reports for individual companies in report of State mine inspector for 1910.

l Fay, A. H., Metal-mine accidents in the United States during the calendar year 1911: Technical Paper 40, Bureau of Mines, 1913.

m Includes quarry employees.

n Includes those employed in phosphate mines.

TABLE 24.—Number of men employed in and about the metal and nonmetal (except coal) mines of British North America, 1894-1911.

Province.	1894	1895	1896	1897	1898	1899	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	Total.
British Columbia.....					a2,000	71,500	3,730	b4,222	63,687	62,750	63,465	63,710	63,982	63,947	63,704	63,254	63,700	63,304	47,450
Newfoundland:																			
Copper.....							402	368	448	624	569	570	450	320	325	450	526	.....	5,072
Iron ore.....							805	953	791	814	1,131	1,145	1,370	1,730	1,489	1,550	1,670	.....	13,598
Pyrites.....									225	250	285	280	210	95				.....	1,205
Total.....							1,267	1,321	1,464	1,718	1,985	1,945	2,030	2,145	1,814	2,000	2,196	.....	19,887
Nova Scotia, gold.....	409	517	555	705	533	529	537	888	761	591	429	503	517	500	500	500	100	300	9,675
Ontario:																			
Cobalt and silver.....					59	50	50	65	50	32	57	475	1,057	2,038	2,111	3,251	3,317	3,555	16,470
Copper and nickel.....	655	444	485	535	637	839	1,444	2,284	1,445	1,277	1,063	1,176	1,117	1,821	1,732	1,706	2,210	2,129	21,612
Gold.....	92	237	189	438	580	603	750	585	726	403	230	279	211	160	358	300	319	397	7,040
Iron.....			125	130	100	87	430	360	388	324	191	278	204	276	366	331	561	685	1,905
Total.....	783	721	814	1,148	1,581	2,022	3,300	3,713	4,461	3,417	3,553	5,285	5,100	6,267	7,489	68,482	69,649	11,731	79,616
Quebec.....					a2,100	a2,756	a2,458	a2,752	a2,719	a2,412	a2,817	a2,767	a2,936	a3,411	a4,362	a3,579	4,125	3,686	43,788
Grand total.....	1,192	1,238	1,369	1,854	6,214	6,807	11,391	13,036	13,062	10,888	12,249	14,220	14,566	16,266	18,529	17,815	20,377	19,311	200,414

^a Figured on the basis of the reports for the individual mines, probably several hundred out of the way.^b Includes those employed in nonproducing mines.^c Includes metal and nonmetal mines, but excludes salt and petroleum, cement and brick works, quarries, etc.^d Excludes men employed in brickyards, kilns, and quarries.

TABLE 25.—Number of men employed in and about the principal metal and nonmetal (except coal) mines of Great Britain and certain British colonies, 1894-1911.

Province or colony.	1894	1895	1896	1897	1898	1899	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	Total.
Great Britain:																			
Metal mines ^a			33,119	33,500	34,231	35,157	34,465	32,443	30,812	29,823	29,504	29,151	30,231	31,602	29,927	28,437	28,676	29,025	500,103
Iron mines ^b	15,447	16,087	16,819	17,235	17,252	17,216	16,716	16,509	16,528	15,257	15,157	16,272	16,840	17,494	18,025	18,361	18,492	19,074	304,781
Other mines.....	30,560	30,199	30,924	29,947	30,212	31,745	30,900	30,021	28,288	27,064	28,271	27,883	28,584	29,629	27,483	26,366	26,889	27,267	522,783
Total.....	46,007	46,286	47,743	47,182	47,464	48,961	47,616	46,530	44,816	42,921	43,428	44,106	45,424	47,123	45,508	44,727	45,381	46,341	827,564
Australasia:																			
New South Wales—																			
Gold, placer mines.....	8,742	11,331	9,938	9,030	8,303	8,030	8,387	5,409	5,434	5,906	5,253	5,091	4,255	3,250	2,851	2,384	2,355	1,836	107,785
Gold, lode mines.....	8,465	10,103	12,069	12,256	11,616	11,318	9,571	6,655	5,176	5,341	5,395	5,218	4,561	4,218	3,512	3,201	2,892	2,814	124,381
Total for all gold mines.....	17,207	21,434	22,007	21,286	19,919	19,348	17,958	12,064	10,610	11,247	10,648	10,309	8,816	7,468	6,363	5,585	5,247	4,650	232,166
Copper mines.....		645	868	1,710	1,976	2,369	3,334	2,964	1,699	1,816	1,850	2,171	3,047	3,764	2,745	2,024	2,286	2,151	38,229
Silver mines.....	4,208	4,658	5,555	6,204	6,396	7,893	8,196	6,298	5,382	6,035	7,071	7,887	9,414	10,021	7,560	6,207	7,909	8,495	125,479
Other mines.....	2,028	1,963	2,106	2,029	2,020	2,687	2,766	2,574	2,890	4,344	4,122	4,428	6,070	5,149	4,213	4,020	3,837	4,064	61,610
Total.....	24,088	28,923	30,478	31,229	30,311	32,297	32,254	24,200	20,581	23,442	23,691	24,795	27,347	26,402	20,881	17,836	19,369	19,360	457,484
New Zealand—																			
Gold, placer mines.....	9,413	8,859	8,967	9,100	8,951	8,628	9,235	8,137	7,591	6,613	6,141	5,804	4,836	5,398	4,567	3,768	3,757	3,227	122,992
Gold, lode mines.....	2,140	2,533	4,259	5,098	4,721	4,663	4,267	4,595	3,807	3,597	4,757	3,588	3,715	3,740	4,118	3,727	4,324	4,138	71,807
Total for gold mines.....	11,553	11,412	13,226	14,198	13,672	13,291	13,502	12,732	11,398	10,210	10,898	9,392	8,551	9,138	8,685	7,495	8,081	7,365	194,799
Queensland—																			
Gold mines ^c	11,428	10,636	10,364	12,835	11,272	9,758	10,163	9,438	9,045	9,229	9,620	10,641	9,842	7,934	7,687	7,150	6,115	5,227	168,384
Other mines.....	2,293	2,497	1,163	2,052	863	2,803	2,163	2,649	2,561	3,980	4,442	5,514	6,969	7,935	6,482	5,234	6,227	5,993	71,840
Total.....	13,721	13,133	11,527	14,887	12,135	12,561	12,326	12,087	11,606	13,209	14,062	16,155	16,831	15,869	14,169	12,384	12,342	11,220	240,224
Victoria. Gold mines.....	27,889	29,897	32,123	32,820	30,804	30,114	29,035	27,777	26,151	25,208	24,331	25,369	25,364	23,291	20,853	18,671	16,553	14,051	460,241
Western Australia. Gold mines.....		21,460	20,236	17,903	13,066	16,080	16,747	16,775	17,825	17,329	16,848	16,832	16,608	16,058	15,130	14,007	15,471	14,794	285,169
Total for five Provinces.....	77,251	104,825	170,590	109,858	99,988	104,443	103,864	93,571	87,561	89,398	89,830	92,543	94,641	90,758	79,718	72,393	71,816	66,790	1,638,017

^a Figures cover all mines included under the Metalliferous Mines Regulation Act.

^b Figures do not include open-pit mines.

^c Includes silver, lead, and zinc mines.

^d Year ending Mar. 31, following year.

^e Figures include lode and placer mines.

^f Figures for lode mines only.

TABLE 25.—*Number of men employed in and about the principal metal and nonmetal (except coal) mines of Great Britain and certain British colonies, 1894-1911*—Continued.

Province or colony.	1894	1895	1896	1897	1898	1899	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	Total.
Cape Colony, Kimberley diamond mines.....	7,496	9,706	9,730	10,417	12,283	12,679	9,222	11,230	12,056	12,643	14,162	18,307	23,884	21,773	11,858	14,726	17,573	.....	229,535
Ceylon.....	.....	9,949	.....	21,652	.....	56,845	77,782	.....	38,912	.....	41,357	53,211	55,503	73,507	65,803	99,862	57,994	16,513	661,040
Gold Coast, gold mine ^a.....	.....	.....	.....	.....	2,913	.....	.....	.....	.....	6,779	17,044	12,969	14,156	15,257	15,796	15,863	19,138	.....	119,917
India:	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Gold mines ^b.....	.....	.....	.....	.....	23,658	24,046	295,026	25,506	27,810	28,020	30,600	32,755	35,598	36,671	34,635	33,877	30,583	.....	389,317
Mica mines.....	.....	.....	.....	.....	31,339	11,266	9,517	9,249	9,500	9,099	13,592	15,579	16,247	17,983	15,277	9,865	13,501	15,574	197,588
Total.....	.....	.....	.....	.....	55,017	35,312	34,543	34,725	37,310	37,119	44,192	48,334	51,775	54,654	49,912	43,742	44,084	15,574	586,805
Transvaal, gold mines.....	48,156	61,650	73,387	78,657	92,806	(4)	(4)	613,101	29,895	58,324	90,089	144,517	150,842	167,569	173,352	183,656	203,023	299,387	1,778,351
Grand total.....	132,903	187,330	190,707	258,254	297,238	244,406	259,876	185,070	236,546	234,686	326,378	400,072	421,632	455,030	426,366	449,714	442,240	337,289	5,516,885

^c Six months total only.

^c Returns incomplete.

^d No returns made on account of war.

^a Figures include lode and placer mines.

^b Includes Mysore gold mines.

TABLE 26.—Number of men employed in and about the principal metal and nonmetal (except coal) mines of various foreign countries, 1894-1911.^a

Country.	1894	1895	1896	1897	1898	1899	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	Total.
Austria:																		
Iron mines.....	4,331	4,502	4,829	5,269	5,323	5,362	5,630	5,871	5,358	4,490	4,249	4,796	5,191	5,241	5,416	5,437	5,607	86,902
Other mines <i>b</i>	13,262	12,930	13,011	12,974	12,863	13,151	13,210	12,747	12,651	12,214	12,076	12,259	11,895	11,397	11,397	10,787	10,394	209,949
Total.....	17,593	17,432	17,840	18,243	18,186	18,513	18,840	18,618	18,009	16,704	16,325	17,055	17,086	17,169	17,853	16,224	16,201	296,851
Belgium, ore mines.....	2,199	2,201	2,017	1,934	1,679	1,493	1,437	1,196	800	943	828	698	866	1,022	855	708	304	21,300
France.....	12,350	11,326	11,951	13,103	13,475	16,038	16,815	16,296	15,848	16,517	17,505	18,261	20,646	24,197	24,179	24,436	27,183	300,126
Greece.....	6,097				9,080	9,346	9,500			10,135	9,893	9,954	11,003	11,720	10,288	8,389	6,433	112,348
Italy <i>c</i>	51,997	43,100	46,352	53,576	57,849	64,300	67,748	67,665	63,270	62,954	62,385	63,996	62,558	59,597	56,401	52,648	49,965	986,391
Japan:																		
Metal mines.....									60,339	64,859	69,133	69,332	73,751	76,721	69,443	74,105	74,736	632,419
Nonmetal mines.....									7,706	7,329	7,395	6,773	7,582	8,946	6,157	7,207	9,992	69,087
Total.....									68,045	72,188	76,528	76,105	81,333	85,667	75,600	81,312	84,728	701,506
Portugal.....						4,132		4,018	3,789	4,159	3,480	4,557	4,673	3,928	6,991	7,898	6,354	54,139
Prussia:																		
Ore mines.....	61,703	62,887	63,307	64,971	65,491	67,458	69,868	69,132	66,853	65,766	66,824	68,520	69,873	71,167	68,873	66,289	64,740	1,133,722
Other mines.....	11,882	11,945	12,732	14,277	15,335	16,242	17,361	18,351	18,445	19,338	21,401	23,152	25,339	27,274	28,279	27,639	28,945	338,187
Total.....	73,585	74,832	76,039	79,248	80,826	83,700	87,429	87,483	85,298	85,104	88,225	91,672	95,212	98,441	97,152	93,928	93,685	1,471,909
Russia:																		
Gold and platinum mines.....								88,745	88,573	89,496	80,808	76,504	73,990	73,006	81,825			632,947
Other mines and workings.....								465,500	66,453	54,975	51,898	55,137	59,974	62,276	59,331			474,544
Total.....								154,425	154,026	144,471	132,706	131,641	133,964	135,282	141,156			1,127,491
Saxony, ore mines.....			5,534	5,129	4,620	4,199	3,861	3,797	3,585	3,303	3,162	2,587	2,620	2,504	2,373	2,159	1,941	51,347
Grand total.....	163,821	148,941	159,733	171,233	185,725	201,721	205,630	353,318	412,730	416,478	411,037	416,526	429,961	439,527	431,808	287,662	287,584	5,123,495

^a Figures taken from Great Britain, Mines and Quarries, General Report and Statistics, 1894 to 1910.
 Excludes salt, ozocerite, coal, and petroleum workings.

^c Does not include salt works, quarries, or turbaries.
d Estimated.

CLASSIFICATION BY CAUSES.

Tables 27 to 39 (pp. 217-245) give a summary of some 12,000 fatalities and 32,000 injuries in and about the metal mines of the world. The figures for these tables were compiled so far as possible from the official reports of the several States, Provinces, and countries. The statistics for the continental countries and for the British colonies outside of British North America and Australasia were taken from the general report and statistics published annually by the British Home Department. Though the figures for the United States do not represent the total number of accidents in the metal and non-metal mines, due to the fact that complete figures are unavailable, yet of the 5,764 deaths reported in the list of fatalities by years in Table 8, 5,066 deaths have here been classified according to causes. Substantially all the deaths and injuries reported in the tables showing deaths and injuries by years for the other countries are represented in the summary of such deaths and injuries by causes.

These tables have been compiled for the purpose of showing, by means of figures covering a considerable number of years and as many States and countries as possible, where the operator and superintendent must look for the causes of injury in and about the mines, of directing attention to the principal causes of injury, and of showing the need of a comprehensive set of statutory rules and regulations, such as are contained in the proposed code of regulations forming the basis of this report. It was considered that figures covering accidents in the metal mines of the world for approximately two decades would be representative and would fairly apportion the various risks and hazards in the mines, since any unusual number of deaths or injuries from a particular cause for any one year would be counter-balanced by the other causes in the other years.

A careful study of the provisions of the committee's proposed code of safety rules and regulations leaves little room for doubt that many accidents in and about the metal mines would be prevented by rigid enforcement of the code. All important recurring causes of injury, as shown by these tables, are guarded against by adequate provision so far as possible. The most elaborate set of rules and regulations will accomplish little, however, without the maintenance of an intelligent and effective supervisory system on the part of the operator, and without the feeling of respect for the law on the part of both operator and miner, which result in a higher standard of discipline.

CAUSES OF MINE ACCIDENTS.

The causes of mine accidents are many and varied. Any extended study of such accidents, however, leads to the conclusion that they naturally fall into two groups or classes. The first group includes those that might be termed preventable. That is to say, the accidents coming under this head might have been prevented by the exer-

cise of ordinary care, prudence, or foresight. The accidents in the second group, which for want of a better name may be designated as nonpreventable accidents, include those resulting from the inherent dangers and hazards of the work itself, and against which human foresight, skill, and care seem powerless to guard. Such accidents probably amount to less than half of the total number.

It has been stated that accidents are the inevitable accompaniment of mining, but granting that this is true to the extent indicated by the above classification, no valid reason exists why the number of preventable accidents can not be materially reduced, and particularly in the mines of the United States and British North America. The summation of accidents by causes in these tables does not show the vastly higher rate in the metal mines of these two countries as compared with other and older mining countries. The tables do show, however, that the causes of injury are about the same over the whole world, the difference being that more men are killed proportionately from these causes in the metal mines of the United States and British North America than is the case elsewhere, save in the Transvaal.

CONTRIBUTING CAUSES.

In the examination of the various reports and in the perusal of the detailed accounts of the accidents included in these tables, several facts stand out prominently. The first is that the experienced miner is not at all exempt from underground accident. In many cases constant exposure to risk makes the miner forgetful or heedless of the dangers confronting him. The old hand is furthermore likely to evince considerable unwillingness to employ the safety devices furnished by the operator. The second fact is that the relatively safe parts of the mine are responsible for an unduly high proportion of accidents. This, of course, is to be accounted for by the fact that when the men are in dangerous places they exercise a higher degree of care to avoid danger, and when they are in less dangerous places they become heedless or forgetful. The third is that in times of scarcity of labor when the operator is compelled to employ anyone willing to engage in this line of work, the lack of a common language between the supervisor and the workman in which instructions can be given and warnings issued is a constant menace and source of injury.

The fourth is that the spirit of restlessness and desire for change, characteristic of the metal miner in the United States, is responsible for many injuries. The shifting character of the working force in the mine and the necessity of keeping the men as long as possible has brought about a state of lax discipline. When the men are constantly changing from one mine to another it requires some little time before they can learn the dangerous places, and doubtless many accidents can be attributed to the lack of familiarity with conditions in the particular mine. Youth is also a factor in mine accidents,

generally in the form of inexperience and willingness to take unnecessary risks.

It is hoped that it may be possible at some time in the future for a qualified inquiry to be undertaken which will show the relative frequency of accidents with respect to the experienced and inexperienced miner, and which will show the number of years experience in the mines of each miner killed or seriously injured. It is also to be hoped that it may be possible to show at the same time the comparative death and injury rates among the English and non-English speaking miners and mine laborers.

A factor of great influence on the safety of underground work is the state of health of the miners. It is a matter about which little is known specifically, although it is entirely obvious that the mental and physical effect on anybody subject to sickness or disease will be to make him much more prone to accident. It seems probable that one result of the more drastic workmen's compensation laws that are being adopted by one State after another will be an increased study of this important subject.

RESPONSIBILITY FOR MINE ACCIDENTS.

RESPONSIBILITY OF OPERATOR AND SUPERINTENDENT.

The first responsibility must rest with the operator. It is his duty to provide adequate safety devices for the protection of the miners. It is his duty to select a careful and experienced superintendent who can enforce discipline and compel compliance with safety rules and regulations. If the superintendent can not enforce wholesome and desirable rules, it is the duty of the operator to replace him with one who will and can.

The responsibility rests next with the mine superintendent. He is responsible for the management of the mine, for the enforcement of discipline, and the selection of his subordinates. It frequently appears in the annual reports of the various State mine inspectors, that the inquest held over the body of a deceased miner develops the fact that such miner had violated some rule of the mine. This indicates a lamentable lack of discipline. Many injuries can thus be traced to the failure to enforce important rules. It is futile, for example, to warn a miner that failure to bar down all loose rock from the back of his working place is dangerous, to call his attention to a rule of the mine forbidding such a practice, and then permit him to go ahead and do the very act forbidden. The frequent repetition of such instances creates the impression that rules of this character are not intended to be enforced and are designed only for the protection of the company in case a suit for damages is brought for injuries resulting from doing this particular act, when the defense would be made that the miner knowingly violated a rule of the mine. The operator or superintendent can not evade the responsibility resting upon him by taking refuge behind a plea of this character.

The handling of a large body of men requires the adoption of a set of strict rules and regulations entirely aside from the laws of the State. Where the character and disposition of individual miners differ so greatly there must of necessity be but one standard of conduct, and individual plans and methods must be subordinated to a general and well-ordered system. The safety of an individual miner largely depends upon the care and prudence exercised by his fellow workers. Unless he can know with some degree of certainty the extent with which he may rely upon their properly discharging their duties, it will be impossible for him properly to perform the duties assigned to him, and the natural hazards of his occupation will be enormously increased.

The operator or superintendent may not always be cognizant of the continual violation of an important rule, yet it must be apparent that if proper efforts had been made to see that the rules were obeyed and complied with a continual violation must have been discovered and prevented. The unchecked violation of a rule or the constant performance of a forbidden action inevitably breeds contempt on the part of the miner toward the requirements of such rules or of the mining laws of the State. The superintendent who is unable to enforce wholesome and necessary safety rules is unfit for the responsible position he holds.

The duty of the operator or superintendent does not cease when he has furnished means of safety and issued general instructions. He should see to it that the one is properly used and the other implicitly obeyed. Under no circumstances should the miner be permitted to jeopardize the lives of his fellow workmen, nor should a foreman or other subordinate official of the mine be permitted to jeopardize the lives of those in his charge. The miner who persists in violating a rule intended for his own protection and that of his fellow workmen should be immediately discharged, and a subordinate who is unwilling or unable to see that wholesome rules are complied with should be forthwith removed. It is possible that if the superintendent or foreman will not discharge men who decline to obey rules promulgated for their safety laws may be passed making such action compulsory.

The superintendent and mine foreman must be actuated with a feeling of respect toward the provisions of the law, as well as toward the rules of their own company, before they can hope to inculcate a like feeling in their men. A careless foreman means careless workmen. A laxity in complying with the provisions of the law or the terms of company rules is responsible for loose practices and carelessness on the part of the men. If the men in charge of particular parts of work in the mine are made to feel that they personally are responsible whenever an accident happens to the men immediately under their charge, this will necessarily induce a more painstaking attention to details on their part, and a far higher degree of caution and prudence.

EFFECT OF LABOR CONDITIONS.

Some reasons for the failure to maintain a higher degree of discipline in the mine and for the failure of the operator or superintendent to discharge the responsibility resting upon him in this respect are to be found in labor conditions. It is a common saying in times of scarcity of mine help that every man is a miner. This may be attributed perhaps to two causes: First, the rapid development of the industry, and, second, the constant and increasing competition with other industries. The combination of these causes has undoubtedly compelled operators to take unskilled and inexperienced men. Again, the necessity for keeping the men has probably brought about a laxity of mine discipline and, in consequence, loss of life. It is unquestionably true that in mining districts where a considerable number of foreign laborers are employed much of the alleged lack of intelligence on the part of the workmen is due to a lack of comprehension which the possession of a common language would remove.

It seems to be a frequent practice for men who have been employed underground as trammers or laborers to go to another district or mine and apply for a job as miner. If labor is scarce the examination as to the qualifications of the applicant for the position sought is apt to be a superficial one, and while doubt might exist as to the knowledge and experience of the applicant, yet he will be assigned to work of which he is almost entirely ignorant, without further questioning. A slight increase in wages is thus sufficient to induce men to assume the increased dangers incident to the use of explosives and the mining of the ore.

It is understood, however, that many large companies now require the applicant for the position of miner to submit a written application giving in detail his previous experience and the names of the mines in which that experience has been acquired. This system if rightly carried out, and if the investigation of the applicant's experience is thorough, would greatly tend to reduce the number of accidents resulting from the employment of inexperienced men for dangerous work.

If experienced men can not be employed, then it devolves upon the operator to use not ordinary precaution, but extraordinary precaution. Only experienced men with a reputation for prudence and carefulness should be assigned to the more dangerous places, and every effort should be made to instruct the workers in their duties, and in the means of avoiding the dangers to which they are of necessity exposed.

RESPONSIBILITY OF MINER.

Finally the responsibility rests upon the miner to exercise care in the face of danger, and not to neglect simple precautions merely because injury has not happened through their neglect in the past. If miners were held to a high standard of care, if they were given to understand that a failure to comply with the rules of the mine would

result in dismissal, and if this step were taken in a few instances, the miner would soon recognize the necessity of compliance.

The prevention of accidents from fall of rock and from explosives largely depends upon the caution of the individual miner. The vast majority of accidents under the head of explosives could be prevented by reasonable care. Such things as returning to a shot within a few minutes after the fuse has been lighted, and when all the charges are known not to have exploded, tamping explosives with an iron bar, crowding explosives into a tight hole, drilling into an old hole after a misfire, and bending over a powder box with a lighted lamp or candle in the cap are wholly inexcusable. Ten to 30 per cent of the accidents in mines are due to such causes. Accidents from failure to replace timbers broken by a shot, or to sound the roof after blasting or after taking down the drilling machine are due to carelessness. Likewise with accidents resulting from failure to use the ladder compartment instead of the skip road, from crawling up a mill hole from below to dislodge rocks that have become stuck and being smothered in the dirt and ore released by the dislodging of the rock, and from jumping on the cage while in motion. Numerous other instances of this sort might be mentioned, but the point is that these causes of injury are entirely within the control of the individual miner; they are some of the things that must be left to his prudence and judgment.

The code presented in this report tries to fix responsibility in every case and the miner is made subject to penalties for violations as well as the operator and the company officers. This is only fair and it may be said that one of the most baffling problems in work along safety lines is the unwillingness of the miner to submit to necessary rules, an unwillingness based more on ignorance than on anything else. To educate employees to an adequate appreciation of the risks of their calling and the need of observing certain precautions to diminish these risks, is vastly more difficult than to frame safety rules, to adopt safety appliances, or to establish safety inspection systems. The existing laws of many States recognize the joint responsibility of the employee with his employer and prescribe penalties for violations of safety regulations by the former. To enact laws and to enforce them are two different matters. The committee has no record of the conviction of a miner for violation of a safety regulation in this country. It is unfortunate that this is true. It does not obtain in other countries. In Australasia, for example, such convictions are not at all infrequent. In the reports of Australian mine inspectors one not infrequently reads of the prosecution and conviction of miners guilty of violating safety provisions applying to the setting of timbers, the handling of explosives, etc. Unquestionably, this has much to do with the excellent showing of the Australasian States in regard to mining death rates.

COOPERATION NECESSARY.

There can be no such thing as placing the responsibility for mining accidents entirely upon the shoulders of the mine operator, the mine superintendent, or the individual miner. The responsibility rests upon them all, each must assume his share and each must discharge it to the best of his ability. It is the duty, as it is probably the desire, of the operators to furnish every known safeguard to life and limb and to provide every safety device that promises to decrease the dangers of mining. It is the duty of the miner to use them whenever possible and it is the duty of the superintendent and foreman to see that they are used.

In order to bring about a reduction in the number of fatal and nonfatal accidents in metal mines, there must be a helpful spirit of cooperation between the mine superintendent and the mine foreman, between the mine foreman and the miners, and lastly among the mine superintendent, foremen and miners, and the mine inspector. Some operators in the past have been inclined to look upon the inspector in somewhat the same manner that a criminal would look upon a police officer. They felt it necessary to conceal everything possible from him and to give absolutely no assistance toward showing the true conditions existing in the mine, with the result that oftentimes important violations or evasions of the law were overlooked. The mining laws are enacted for the mutual protection of operators and miners, and if properly and rigidly enforced the result would do much to lessen the constant danger attending the miners in their hazardous work, and in the betterment of the physical conditions of the miner. The miner himself is in the best position to determine the relative safety of his working place, and he is naturally held responsible therefor, but he is likewise in the best position to point out the dangerous places to the inspector. He is also constantly subjected to a risk of injury at the hands of others, and should not hesitate to call the attention either of the mine foreman or of the mine inspector to violations of the law or of the mine rules.

Whatever may have been the tendency in the past, there can be no doubt that the average operator and superintendent is to-day keenly interested in the prevention of accidents, and is both willing and anxious to use every available means that will assist in accomplishing that end. Fatal accidents are regarded with horror, and the loss of life is taken to heart. Too frequently, however, the lesson is soon forgotten before steps have been taken to remedy the cause and prevent another loss of life therefrom.

The average operator furnishes ample supplies of timber, sees that the powder is thawed and distributed by a man employed for that purpose, has the shafts, cages, guides, and brakes, regularly examined and tested, employs cagers who are the only ones allowed to give signals to the engineer, and employs a competent hoisting engineer; winzes and raises are protected; yet in spite of all this accidents con-

tinue to happen. Lax mine discipline, failure to provide adequate safety devices, inexperienced workmen, scarcity of help, non-English speaking laborers, heedlessness or forgetfulness on the part of the miners, all contribute to swell the number of accidents.

The remedy for these conditions must be sought along the line of the general education of the miner as to the requirements of his work and an intelligent supervision of such work on the part of the operator and superintendent, as well as a rigid enforcement of safety rules and regulations.

Perhaps the placing of a suggestion box at the shaft house, such as is now generally employed in mercantile establishments, in which miners might drop either signed or unsigned communications and suggestions regarding the possible improvement of conditions in the mine might be helpful if these suggestions were examined daily by the superintendent, and the payment of a slight cash reward for suggestions adopted might contribute to the betterment of conditions.

Most mine foremen are probably doing all that they can in the way of instructing those under them, but the constant pressure from above to get out increasing quantities of ore at decreasing costs, renders them unable to meet the demand for instruction which inexperienced help requires. This pressure is felt by the men also, so that in their desire to make a showing they are led to neglect simple precautions. This pressure should not be exerted to the extent of inducing careless or dangerous practices if the number of mining accidents is to be lowered.

CAUSES AND DISTRIBUTION OF ACCIDENTS.

The foregoing general discussion relates to what might be termed the underlying causes of accidents. The tables which follow give in detail the physical nature of the causes resulting either in injury or death.

Table 27 shows that four causes, namely, fall of rock or ore from roof or wall, explosives, falling down shaft, and hoisting accidents, constitute approximately two-thirds of the fatal accidents in and about the mines. The remaining 31 or 32 causes constitute only one-third of the total number. This table shows further that the relative percentage of these causes with reference to the total number of deaths and injuries remains practically constant for the mining industry generally throughout the world, the total average for all the countries represented in the table for these causes being 62 per cent, while the total for the same causes for the United States is 66 per cent.

Tables 28 and 29 give the total number of deaths by causes for the United States and various foreign countries, together with the relative percentages thereof for the years 1894-1911. It is noticeable that the deaths by explosives in Canada are twice as high as in any other mining country, the accidents caused by drilling or picking into misfires and other unexploded product being unusually high and about four or five times as high as for any other country. The tables further show that the underground accidents, which represent the

true mining accidents, constitute about eight-tenths of the deaths in and about the mines.

Figure 1 shows the relative percentages of the principal causes of death in and about the metal mines of the United States for 18 years, or for the period 1894-1911. The chart exhibits in striking manner the relative importance of falls of rock, explosives, falls down shaft, and cage accidents, as compared with the remaining causes.

Tables 30 and 31 show the deaths by States and causes for the United States for the 18-year period, with the percentages of such causes. The figures are given by counties where county inspection is maintained. These tables show that deaths by falls of rock are greater in the lead and zinc mines of Missouri than in the mines of any other State. The accidents from explosives underground represent about 19 per cent of the entire number. The accidents from

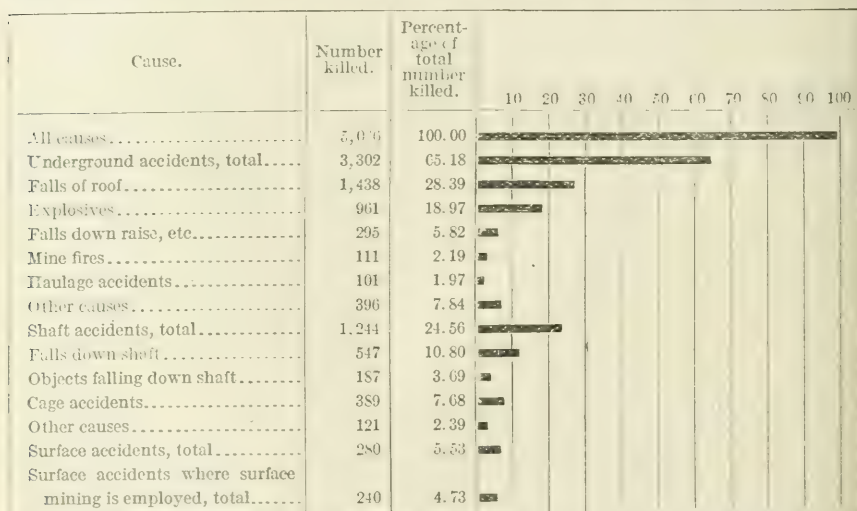


FIGURE 1. -Relative percentages of causes of 5,066 deaths occurring in the metal mines of the United States for the period 1894-1911. The figures include only those States having mine inspection service.

electricity constitute but a small percentage of the total number, but it has been noticeable that the electrical accidents have on the whole been increasing in the past few years, this, of course, being due to the increased use of electricity in and about the mines. Surface mining accidents constitute but a small portion of the total number, with the exception of the State of Minnesota, in which State they constitute nearly one-half of the total number of accidents for the period covered, probably due to the great amount of open-pit mining there conducted. Mine fires constitute but 2.19 per cent of the total number of accidents for the entire United States, but for the past few years in the State of Nevada they constitute nearly one-third of the entire number of accidents. Haulage accidents underground constitute a relatively unimportant part of the total, amounting to but 1.97 per cent for the United States. One-twentieth of all accidents are accounted for by falling

down raises, winzes, etc. For Idaho, however, this class of accidents constitutes 19.3 per cent and for Montana 13.16 per cent, which is extremely high as compared with the other States. Missouri and Tennessee show the largest percentage of deaths due to objects falling down shafts, this in the case of Missouri being due to the insecure couplings used on the tub hoists in the earlier years. Michigan shows the highest percentage of shaft accidents, or about 31 per cent, of the total; for Houghton County the proportion reaches 39.75 per cent.

Tables 32 and 33 show the deaths by causes in the metal and non-metal mines of British North America and Australasia for the period 1894-1911. The very large number of deaths due to explosives in Canada has already been commented on. Falls of rock or ore cause but 13.35 per cent of the total number of deaths in Canada, whereas in Australasia they cause 34.42 per cent. Falling down shaft constitutes in both cases practically one-tenth of the entire number of accidents as compared with 10.86 per cent for the United States. The percentage of shaft accidents is somewhat lower than in the United States, being about one-fifth in these two countries as against one-fourth in the United States.

Tables 34, 35, 36, 37, 38, and 39 summarize over 32,000 injuries in and about metal mines. These injuries are classified by causes together with the relative percentages of such causes. It is noticeable that the four major causes of fatalities in the mines constitute but one-third of the injuries as compared with two-thirds of the deaths, this, of course, being attributable to the fact that in the majority of accidents coming under these heads death results. It is noticeable also that haulage accidents constitute a much higher percentage of injuries than of deaths, whereas the shaft accidents represent but about 10 per cent of the gross total as compared with 20 per cent of the deaths. The surface and surface-mining accidents remain about constant. The rest of the injuries are fairly well distributed throughout the other causes.

TABLE 27.—Principal causes of deaths and injuries in and about the metal and non-metal (except coal) mines of the United States and certain foreign countries, 1894-1911, percentages of total.

Countries.	By fall of rock or ore.	By explosives.	By falling down shaft.	By cage, skip, or hoist, etc.	Total.
Killed:					
United States ^a	28.39	18.97	10.80	7.68	65.84
British North America.....	13.34	33.08	9.15	6.58	62.51
Great Britain.....	40.24	10.28	8.19	3.66	62.37
Australasia.....	34.42	12.95	10.09	2.87	60.33
Cape Colony (Kimberley diamond mines).....	42.03	13.19	3.43	3.16	61.81
Italy.....	59.38	^b 19.83	.....	.....	79.21
Prussia.....	36.55	^b 11.38	3.96	.....	51.89
Total average.....	35.29	16.79	7.71	4.27	64.06
Injured:					
United States.....	28.65	11.23	1.92	3.71	45.51
British North America.....	16.10	21.39	2.54	6.29	46.32
Great Britain.....	16.67	4.53	0.97	0.63	22.80
Australasia.....	23.04	7.54	2.26	1.94	34.78
Cape Colony (Kimberley diamond mines).....	17.53	5.34	0.33	1.70	24.90
Italy.....	43.93	^b 27.81	.....	.....	44.74
Total average.....	23.39	9.23	1.47	1.94	36.03

^a Figures include only those States having mine inspection service.

^b Includes accidents from mine fires and mine gases.

Country.	Surface.										Surface (where surface mining is performed).							
	By fall of person.	By mine cars or mine loco- motives.	By railway cars and loco- motives.	By run or fall of ore in or from ore bins.	By boiler explosions.	By electricity (shock or burns).	By machinery.	By other causes.	By mill and smelting plant accidents.	Total, surface.	By falls or slides of rock or ore.	By explosives (includes premature blasts, flying pieces from blasts, etc.).	By mine cars or loco- motives.	By steam shovels.	By falls of person.	By other causes.	Total, surface (where min- ing is performed).	Grand total.
United States ^a	27	53	7	6	5	9	61	77	35	280	57	41	95	16	15	16	240	5,068
British North America.....	8	15	7	1	1	5	10	26	26	99	10	1	.....	2	2	3	16	547
Great Britain metal mines ^b.....	.....	21	.....	.....	1	.....	22	39	.....	83	.....	.....	.....	.....	.....	.....	.....	574
Australasia.....	20	13	.....	2	2	9	64	60	10	180	111	13	4	7	76	211	2,231	
Cape Colony, Kimberley diamond mines.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	80	13	38	4	9	52	196	728
Italy.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1,582
Prussia, ore and other mines.....	.....	.....	.....	.....	.....	.....	.....	246	.....	246	.....	.....	.....	.....	.....	51	51	1,715
Grand total.....	55	102	14	9	9	23	157	448	71	888	258	68	137	20	33	198	714	12,443

^a Figures include only those States having mine-inspection service.

^b Figures cover all mines included under Metalliferous Mines Regulation Act.

^c Includes accidents from mine gases, powder fumes and gases, and mine fires.

^d Includes accidents from mine fires and gases.

^e Includes only those fatalities that could be classified.

TABLE 29.—Percentage of number of men killed in and about the principal metal and nonmetal (except coal) mines of the United States and foreign countries, 1894-1911, with fatalities classified according to cause.

Country.	Underground.										Shaft.												
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total, underground.		17	18	19	20	Total, shaft.
	By fall of person, staging, etc.	By fall of rock or ore from roof or wall.	By timber or hand tools.	By explosives (includes premature blasts, flying pieces from blasts, etc.).	By explosions of misfires, drilling into old bottoms, etc.	By suffocation from powder fumes, etc.	By thawing explosives.	By haulage accidents (by mine cars, etc.).	By falling down chute, winze, raise, slope, or mill hole, etc.	By run of ore from chute or pocket.	By drilling accidents (by machine or hand drills).	By electricity (shock or burns).	By machinery (pumps, hoisting and haulage machinery, etc., not including mine locomotives or machine drills).	By mine fires (burned, suffocated, etc.).	By intrush of water.	By other causes.	Total, underground.		By falling down shaft.	By objects falling down shaft.	By being struck or crushed by cage, skip, bucket, or hoist, etc.	By other causes.	Total, shaft.
United States a	1.74	28.39	0.81	12.59	3.12	2.82	0.44	1.97	5.82	0.97	0.28	0.71	0.40	2.19	0.34	2.59	65.18	10.80	3.69	7.68	2.39	24.56	
British North America	1.28	13.34	0.37	12.06	11.41	3.12	1.46	1.28	3.30	0.73	0.37	0.37	1.05	0.18	0.35	1.65	58.50	9.51	2.93	6.58	1.46	20.48	
Great Britain, metal mines b	1.39	40.24	0.09	8.76	0.35	0.17	2.09	2.09	3.23	0.27	0.18	0.27	2.02	4.88	0.17	9.76	68.47	8.19	2.61	3.66	2.61	17.07	
Australasia	1.39	34.42	0.46	9.50	1.03	2.42	0.72	0.72	3.23	0.27	0.18	0.27	2.02	0.36	0.33	3.29	61.75	10.09	4.39	2.87	3.36	20.71	
Cape Colony, Kimberley diamond mines	0.82	42.03	0.14	12.30	0.01	0.69	1.10	1.10	3.71	0.14	0.14	0.27	0.69	0.96	0.06	1.51	64.56	3.43	1.24	3.16	0.69	8.52	
Italy	59.38	4.01	0.01	8.05	0.47	2.86	0.06	0.06	3.40	0.48	0.16	0.37	0.35	0.06	0.61	20.79	100.00	3.96	2.01	18.67	21.63	61.05	
Prussia	36.55	0.43	0.43	10.17	2.17	4.26	0.24	1.17	3.40	0.48	0.16	0.37	0.35	1.25	0.35	6.90	68.25	7.75	2.01	4.28	4.24	18.88	
Total average	1.06	35.22	0.43	10.17	2.17	4.26	0.24	1.17	3.40	0.48	0.16	0.37	0.35	1.25	0.35	6.90	68.25	7.75	2.01	4.28	4.24	18.88	

Country.	Surface.										Surface. (Where surface mining is performed.)						Total average.
	By fall of person.	By mine cars or mine loco- motives.	By railway cars and loco- motives.	By run or fall of ore in or from ore bins.	By boiler explosions.	By electricity (shock or burns).	By machinery.	By other causes.	By mill and smelting plant accidents.	Total, surface.	By falls or slides of rock or ore.	By explosives (includes premature blasts, flying pieces from blasts, etc.).	By mine cars or loco- motives.	By steam shovels.	By falls of person.	By other causes.		Total, surface (where surface mining is per- formed).
	21	22	23	24	25	26	27	28	29		30	31	32	33	34	35	
United States ^a	0.53	1.05	0.14	0.12	0.10	0.18	1.20	1.52	0.69	5.53	1.12	0.81	1.88	0.31	0.30	0.31	4.73
British North America.....	1.46	2.74	1.28	0.18	0.17	0.92	1.83	4.75	4.75	18.09	1.83	0.18	.....	0.37	0.55	0.55	2.93
Great Britain, metal mines ^b.....	.....	3.66	.....	.....	0.17	.....	3.83	6.80	.....	14.16	.....	.....	.....	.....	.....	.....	.....
Australasia.....	0.90	0.58	.....	0.09	0.09	0.40	2.87	2.69	0.45	8.07	4.98	0.58	0.18	0.31	0.31	3.41	9.46
Cape Colony, Kimberley diamond mines.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	10.99	1.78	5.22	0.55	1.24	7.14	26.92
Italy.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Prussia.....	.....	.....	.....	.....	.....	.....	.....	14.35	.....	14.35	.....	.....	.....	.....	.....	2.97	2.97
Total average.....	0.44	0.82	0.11	0.07	0.07	0.19	1.26	3.60	0.57	7.13	2.07	0.55	1.10	0.27	1.59	1.59	5.74

^a Figures include only those States having mine-inspection service.

^b Figures cover all mines included under Metalliferous Mines Regulation Act.

TABLE 30.—Number of men killed in and about the metal and nonmetal except coal mines of the United States, a 1894-1911, with fatalities classified according to cause.

State.	Underground.														Shaft.				Total, shaft.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total, underground.		
	By fall of person, structure, etc.	By fall of rock or ore from roof or wall.	By timber or hand tools.	By explosives (includes premature blasts, flying pieces from blasts, etc.	By explosions of furnaces, drilling into old bottoms, etc.	By suffocation from powder fumes, etc.	By thawing explosives.	By hanging accidents (by mine cars, mine locomotives, breakage of ropes, etc.).	By falling down chutes, winzes, raises, slope, or mill hole, etc.	By run of ore from chute or pocket.	By drilling accidents (by machine or hand drills).	By electricity (shock or burns).	By machinery (pumps, hoisting and handling machinery, etc.), not including mine locomotives or machine drills.	By mine fires (burned, suffocated, etc.).	By influx of water.	By other causes.	Total, underground.		
	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
Colorado.....	65	273	12	172	94	46	16	12	84	21	3	5	5	32	4	36	880	77	283
Idaho.....	1	6	6	32		1			17			10			4	1	131	94	9
Michigan:																			
Deshler, County iron mines.....	2	67	4	18	5	12		4	10		1	1			4	3	129	17	29
Gogebie County iron mines.....	7	126	3	21		7		7	15	2		3		3		6	194	68	92
Iron County iron mines.....	1	39		11	7	2	1	2	24	6						3	116	30	47
Marquette County iron mines.....	2	134	7	41		4		18	23	1	2	2	6	8		26	277	53	104
Total for iron mines	12	378	14	94	12	25	1	31	72	9	3	6	6	11	1	38	716	168	272
Houghton County copper mines.....	3	159	7	67	11	11		9	13	12	3	1		30	1	18	360	123	352
Keweenaw County copper mines.....		6		1					1							1	9		5
Total for iron and copper mines.....	15	334	21	162	26	36	1	41	86	21	6	10	6	53	3	57	1,085	291	529

Minnesota.....	1	83	1	26	.....	9	2	15	9	4	.....	1	3	8	5	1	7	168	22	7	04	12	1	42
Missouri.....	4	251	.....	69	10	22	2	7	1	.....	.....	.....	3	.....	.....	.....	.....	420	74	11	7	19	10	174
Montana.....	.....	153	5	102	12	20	1	6	72	3	.....	.....	3	1	.....	.....	.....	401	46	12	2	78	8	146
Nevada.....	1	13	.....	2	2	6	.....	.....	7	.....	.....	.....	3	.....	24	.....	.....	60	10	1	.....	4	.....	14
New York:																								
Iron mines.....	.....	15	.....	9	3	.....	.....	6	.....	.....	.....	.....	.....	.....	.....	.....	.....	35	11	1	.....	7	2	21
Other mines.....	.....	11	.....	11	2	1	.....	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	27	.....	.....	1	.....	.....	1
Total.....	.....	26	.....	20	5	1	.....	8	.....	.....	.....	.....	.....	.....	.....	.....	.....	62	11	2	.....	8	2	22
South Dakota.....	1	33	.....	19	8	2	.....	4	7	.....	.....	.....	1	.....	.....	.....	.....	80	10	2	.....	6	.....	13
Tennessee:																								
Copper mines.....	.....	6	.....	2	1	.....	.....	1	2	.....	.....	.....	1	.....	.....	.....	.....	13	.....	6	.....	.....	.....	6
Iron mines.....	.....	2	.....	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4	.....	.....	.....	.....	.....	.....
Total for iron and copper mines.....	.....	8	.....	4	1	.....	.....	1	2	.....	.....	.....	1	.....	.....	.....	.....	17	.....	6	.....	.....	.....	6
Other mines.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
Total.....	.....	8	.....	4	1	.....	.....	1	2	.....	.....	.....	1	.....	.....	.....	.....	17	.....	6	.....	1	.....	7
Grand total.....	88	1,438	41	638	158	143	22	191	285	49	11	36	20	111	17	131	517	3,302	187	44	389	77	1,244	

a Figures include only those States having mine-inspection service.

TABLE 30.—*Number of men killed in and about the metal and nonmetal (except coal) mines of the United States, a 1894-1911, with fatalities classified according to cause—Continued.*

State.	Surface.										Surface (where surface mining is performed).								Grand total.
	By fall of person.	By mine cars or mine loco- motives.	By railway cars and loco- motives.	By run or fall of ore in or from ore bins.	By boiler explosions.	By electricity (shock or burns).	By machinery.	By other causes.	By mill and smelting plant accidents.	Total, surface.	By falls or slides of rock or ore.	By explosives (includes pre- mature blasts, flying pieces from blasts, etc.).	By mine cars or locomotives.	By steam shovels.	By falls of person.	By other causes.	Total, surface (where sur- face mining is performed).		
Colorado.....	2	8		3		7	30	27	30	107	2				35	36		1,276	
Idaho.....																	6	142	
Michigan:																			
Dickinson County iron mines.....	1	4	6				4	5		23	3				1	1	5	186	
Gogebic County iron mines.....	4	3						2		9				2			2	297	
Iron County iron mines.....		1						1		2					1		1	166	
Marquette County iron mines.....	5	4			1		3	19		32				2			2	415	
Total for iron mines.....	13	12	6		1		7	27		66	3			4	2	1	10	1,064	
Houghton County copper mines.....	5	7					6	4		22								634	
Keweenaw County copper mines.....																		14	
Total for iron and copper mines.....	18	19	6		1		13	31		88	3			4	2	1	10	1,712	
Minnesota.....	2	21					4	13		40	46	36		12	11	8	205	453	
Missouri.....	3	1	1		4	1	13	5		28					1		1	623	
Montana.....																		547	
Nevada.....								1		1	1	3	1				4	79	
New York:																			
Iron mines.....	1	3		3		1	1			3	4		2		1	1	8	72	
Other mines.....									5	6	1						1	35	
Total.....	1	3		3		1	1		5	14	5	2	2		1	1	9	107	
South Dakota.....											1	2					3	101	

TABLE 31.—Percentage of number of men killed in and about the principal metal and nonmetal (except coal) mines of the United States, a 1894-1911, with fatalities classified according to cause.

States.	Underground.																Shaft.						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total underground.	17	18	19	20	21	Total shaft.
	By fall of person, striking, etc.	By fall of rock or ore from roof or wall, fall or cave of ground.	By timber or hand tools.	By explosives (includes premature blasts, flying pieces from blasts, etc.).	By explosions of misfires, drilling into old bottoms, etc.	By suffocation from powder fumes, etc.	By thawing explosives.	By haulage accidents (by mine cars, mine locomotives, breakage of rope, etc.).	By falling down chute, winze, raise, slope, or mill hole, etc.	By run of ore from chute or pocket.	By drilling accidents (by machine or hand drills).	By electricity (shock or burns).	By machinery (pumps, hoisting and haulage machinery, not including mine locomotives or machine drills.	By mine fires (burned, suffocated, etc.).	By intrus of water.	By other causes.	Total underground.	By falling down shaft.	By objects falling down shaft.	By overwinding or failure of brake.	By being struck or crushed by cage, skip, bucket, or hoist, etc.	By other causes.	Total shaft.
Colorado.....	5.09	21.40	0.94	13.48	7.37	3.61	1.25	0.94	6.58	1.65	0.24	0.39	0.39	2.51	0.31	2.82	68.97	6.04	4.23	1.33	7.37	3.21	22.18
Idaho.....	0.70	32.39	1.41	22.54	.....	0.70	.....	4.93	19.02	.....	.....	7.04	.....	.....	.....	0.70	92.25	.....	.....	.....	6.34	.....	6.34
Michigan:																							
Dickinson County iron mines.....	1.07	34.95	2.15	9.68	2.69	6.45	.....	2.15	5.37	.....	0.54	0.54	.....	.....	2.15	1.61	69.35	9.14	1.07	0.54	4.84	.....	15.59
Gogebic County iron mines.....	2.36	40.40	1.01	7.07	.....	2.36	.....	2.36	5.05	0.67	.....	1.01	.....	.....	.....	2.02	65.32	22.90	1.35	.....	6.06	0.07	30.98
Iron County iron mines.....	0.60	35.54	.....	6.63	4.22	1.20	0.60	1.20	14.46	3.62	.....	.....	.....	.....	.....	1.81	69.88	18.07	1.20	.....	9.04	.....	28.32
Marquette County iron mines.....	0.48	32.29	1.69	10.60	.....	0.96	.....	4.34	5.54	0.24	0.48	0.48	1.45	1.93	.....	6.27	66.75	12.77	0.72	2.65	8.92	.....	25.06
Total for iron mines, Houghton County.....	1.13	35.53	1.31	8.83	1.13	2.35	0.09	2.91	6.77	0.85	0.28	0.56	0.56	1.03	0.37	3.57	67.29	15.79	1.03	1.13	7.43	0.19	25.57
..... copper mines.....	0.48	25.08	1.11	10.57	2.21	1.72	.....	1.42	2.05	1.89	0.47	0.63	.....	6.15	0.16	2.84	56.78	19.40	5.68	0.95	11.83	1.89	39.75
Keweenaw County copper mines.....	.....	42.86	.....	7.14	.....	.....	7.14	.....	.....	.....	.....	.....	.....	.....	.....	7.14	64.29	.....	.....	.....	35.71	.....	35.71
Total for iron and copper mines.....	0.88	31.72	1.23	9.46	1.52	2.10	0.06	2.34	5.02	1.23	0.35	0.58	0.35	2.92	0.29	3.33	63.38	17.00	2.75	1.05	9.29	0.82	30.90

Minnesota.....	0.22	18.98	0.22	5.74	1.99	0.44	3.31	1.99	0.88	0.16	0.48	1.28	1.10	0.22	1.55	36.65	4.86	1.54	.....	2.65	0.22	9.27
Missouri.....	0.64	40.29	.....	15.89	1.61	3.53	0.35	1.12	0.16	.....	0.55	0.73	.....	0.16	1.77	67.42	11.88	10.27	1.12	3.05	1.61	27.93
Montana.....	23.07	23.07	0.92	18.65	2.19	3.66	0.18	1.10	13.16	.....	0.55	0.73	0.18	0.36	2.01	73.31	8.41	2.19	0.37	14.26	1.46	26.69
Nevada.....	1.27	16.45	.....	2.53	2.53	7.59	.....	1.27	8.86	.....	3.80	.....	30.38	.....	1.27	75.95	12.66	.....	.....	5.06	.....	17.72
New York:																						
Iron mines.....	.....	20.83	.....	12.50	4.17	.....	.....	8.33	.....	.....	.....	.....	.....	.....	2.78	48.61	15.28	1.39	.....	9.72	2.78	29.17
Other mines.....	.....	31.43	.....	31.43	5.71	2.86	.....	5.71	.....	.....	.....	.....	.....	.....	.....	77.14	.....	.....	.....	2.86	.....	2.86
Total.....	.....	24.30	.....	18.69	4.67	0.93	.....	7.48	.....	.....	.....	.....	.....	.....	1.87	57.94	10.28	0.93	.....	7.48	1.87	20.56
South Dakota.....	0.99	32.08	.....	18.81	7.92	1.98	.....	3.96	6.93	.....	0.99	.....	.....	.....	4.95	79.21	9.90	1.98	.....	5.94	.....	17.82
Tennessee:																						
Copper.....	.....	30.00	.....	10.00	5.00	.....	.....	5.00	10.00	.....	5.00	.....	.....	.....	.....	65.00	.....	30.00	.....	.....	.....	30.00
Iron.....	.....	40.00	.....	40.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	80.00	.....	.....	.....	.....	.....	.....
Total for iron and copper mines.....	.....	32.00	.....	16.00	4.00	.....	.....	4.00	8.00	.....	4.00	.....	.....	.....	.....	68.00	.....	24.00	.....	.....	.....	24.00
Other mines.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	100.00	.....	.....	100.00
Total.....	.....	30.78	.....	15.39	3.84	.....	.....	3.84	7.69	.....	3.84	.....	.....	.....	.....	65.39	.....	23.08	.....	.....	3.84	26.92
Total average.....	1.74	28.39	0.81	12.59	3.12	2.82	0.44	1.97	5.82	0.97	0.28	0.71	0.40	2.19	0.34	65.18	10.80	3.69	0.87	7.68	1.52	24.56

a Figures include only those States having g mine-inspection service.

TABLE 31.—Percentage of number of men killed in and about the principal metal and nonmetal (except coal) mines of the United States, a 1894-1911, with fatalities classified according to cause—(Continued).

State.	Surface.								Surface (where surface mining is performed).								Total average.	
	By fall of person.	By mine cars or mine locomotives.	By railway cars or loco-motives.	By run or fall of ore in or from ore bins.	By boiler explosions.	By electricity (shock or burns).	By machinery.	By other causes.	By mill and smelting.	Total surface.	By falls or slides of rock or ore.	By explosives (includes premature blasts, fly-ing pieces from blasts, etc.).	By mine cars or loco-motives.	By steam shovels.	By falls of person.	By other causes.		Total surface (where surface mining is per-formed).
Colorado.	0.16	0.63		0.23		0.55	2.35	2.11	2.35	8.38	1.41					0.47	0.47	100.00
Idaho.																	1.41	100.00
Michigan:																		
Dickinson County iron mines.	2.15	2.15	3.23				2.15	2.69		12.37	1.61				0.54	0.54	2.69	100.00
Gogebic County iron mines.	1.35	1.01						0.67		3.03				0.67			0.67	100.00
Iron County iron mines.		0.60						0.60		1.20					0.60		0.60	100.00
Marquette County iron mines.	1.21	0.97			0.24		0.72	4.57		7.71				0.48			0.48	100.00
Total for iron mines.	1.22	1.13	0.56		0.09		0.66	2.04		6.20	0.28			0.38	0.19	0.09	0.94	100.00
Houghton County cop-per mines.	0.79	1.10					0.95	0.63		3.47								100.00
Keweenaw County cop-per mines.																		100.00
Total for iron and cop-per mines.	1.05	1.11	0.35		0.06		0.76	1.81		5.14	0.17			0.23	0.12	0.06	0.58	100.00
Minnesota.	0.41	4.64					0.88	2.87		8.83	10.15	7.94	20.31	2.65	2.43	1.77	45.25	100.00
Missouri.	0.48	0.16	0.16		0.64	0.16	2.09	0.80		4.49					0.16		0.16	100.00
Montana.																		100.00
Nevada.								1.72		1.27		3.80	1.26				5.06	100.00

TABLE 32.—Number of men killed in and about the principal metal and nonmetal (except coal) mines of British North America and Australasia, 1894-1911, with fatalities classified according to cause.

Provinces.	Underground.													Shaft.										
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total, underground.			17	18	19	20	Total, shaft.
	By fall of person, staging, etc.	By fall of rock or ore from roof or wall, fall or cave of ground.	By timber or hand tools.	By explosives (includes premature blasts, flying pieces from blasts, etc.).	By explosions of misfires, drilling into old bottoms, etc.	By suffocation from powder fumes, etc.	By thawing explosives.	By haulage accidents (by mine cars, mine locomotives, breakage of rope, etc.).	By falling down chute, winze, raise, slope, or mill hole, etc.	By run of ore from chute or pocket.	By drilling accidents (by machine or hand drills).	By electricity (shock or burns).	By machinery (pumps, hoisting and haulage machinery, etc., not including mine locomotives or machine drills).	By mine fires (burned, suffocated, etc.).	By intrush of water.	By other causes.	Total, underground.			By falling down shaft.	By objects falling down shaft.	By other causes.	By being struck or crushed by cage, skip, bucket, or hoist, etc.	Total, shaft.
British North America:																								
British Columbia.....	6	31		27	33	13	1	7	16	4	1	2			3	7	151	14	1	12	5	32		
Nova Scotia.....		6		2	4		1										13	2	2	2	3	6		
Ontario.....	1	36	2	37	42	15	6		13		1			1		2	156	36	13	22		74		
Total.....	7	73	2	66	79	28	8	7	29	4	2	2		1	3	9	320	52	16	36	8	112		
Australasia:																								
New South Wales.....	15	222	1	35	10	9		7	27	3	4		1	6	1	17	358	44	14	13	2	73		
New Zealand.....		2		8	2	5			1	6			1	2			52	10	4	2	7	23		
Queensland.....	12	122	5	46	3	3		6	2	1			5		4	27	236	49	27	5	25	106		
Victoria.....		223		49		16		2	15				38		6	44	293	57	32	16		105		
Western Australia.....	2	179	1	74	8	21			22	2					1	29	339	65	21	28	41	155		
Total.....	31	708	9	212	23	54		16	72	6	4		45	8	12	118	1,278	225	98	64	75	462		
Grand total.....	38	841	11	278	102	82	8	23	101	10	6	2	45	9	15	127	1,698	277	114	100	83	574		

Provinces.	Surface.								Surface (where surface mining is performed.)						
	By fall of person.	By mine cars or mine locomotives.	By railway cars and loco- motives.	By run or fall of ore in or from ore bins.	By boiler explosions.	By electricity (shock or burns).	By machinery.	By other causes.	By mill and smelting plant accidents.	Total, surface.	By falls or slides of rock or ore.	By explosives (includes premature blasts, fly- ing pieces from blasts, etc.).	By other causes.	Total, surface (where surface mining is performed).	Grand total.
	21	22	23	24	25	26	27	28	29		30	31	32		
British North America:															
British Columbia.....	1	4	1			1	2	13		22	4		1	5	210
Nova Scotia.....	7	11	6	1	1	4	7	13	26	76	6	1	4	11	20
Ontario.....															317
Total.....	8	15	7	1	1	5	10	26	26	99	10	1	5	16	547
Australasia:															
New South Wales.....	11	9		2	2	4	23	25		76	24	9	19	52	559
New Zealand.....	1	1					5	2		9	47	3	67	117	201
Queensland.....	2							10		12	7	1		8	332
Victoria.....											30			30	528
Western Australia.....	6	3				5	36	23	10	83	3		1	4	581
Total.....	20	13		2	2	9	64	60	10	180	111	13	87	211	2,231
Grand total.....	28	28	7	3	3	14	74	86	36	279	121	14	92	227	2,778

TABLE 33.—Percentage of number of men killed in and about the principal metal and nonmetal (except coal) mines of British North America and Australasia, 1894-1911, with the fatalities classified according to cause.

Provinces.	Underground.															Shaft.						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total, underground.	17	18	19	20	Total, shaft.
	By fall of person, staking, etc.	By falling rock or ore from roof or wall, fall or cave of ground.	By timber or hand tools.	By explosives (includes premature blasts, flying pieces from blasts, etc.).	By explosions of misfires, drilling into old bottoms, etc.	By suffocation from powder fumes, etc.	By thawing explosives.	By haulage accidents (by mine cars, mine locomotives, breakage of rope, etc.).	By falling down chute, winze, raise, slope, or mill hole, etc.	By run of ore from chute or pocket.	By drilling accidents (by machine or hand drills).	By electricity (shock or burns).	By machinery (pumps, hoisting and haulage machinery), not including mine locomotives or machine drills.	By mine fires (burned, suffocated, etc.).	By intrush of water.	By other causes.		By falling down shaft.	By objects falling down shaft.	By being struck or crushed by cage, skip, bucket, or hoist, etc.	By other causes.	
British North America:	2.86	14.76		12.86	15.71	6.19	0.48	3.33	7.62	1.90	0.48	0.95					71.90	6.67	0.48	5.71	2.38	15.24
British Columbia.....		30.00		10.00	20.00		5.00										65.00	10.00	10.00	10.00		30.00
Nova Scotia.....	0.32	11.35	0.63	11.67	13.25	4.73	1.89		4.10		0.32			0.32		0.63	49.21	11.35	4.10	6.94	0.95	23.34
Ontario.....																	58.50	9.51	2.93	6.58	1.46	20.48
Total for three Provinces.	1.28	13.35	0.37	12.07	14.44	5.12	1.46	1.28	5.30	0.73	0.37	0.37		0.18	0.55	1.65	58.50					
Australasia:																	64.04	7.87	2.50	2.33	0.36	13.06
New South Wales.....	2.68	39.71	0.18	6.26	1.79	1.61		1.25	4.83	0.54	0.72		0.18	1.07	0.18	3.04	64.04					
New Zealand.....	0.99	10.95	0.99	3.98	0.99	2.49		0.50	2.99							0.50	25.87	4.98	1.99	0.99	3.48	11.44
Queensland.....	3.31	33.70	1.38	12.71	0.83	0.83		1.66	0.55	0.28			1.38	1.10	1.10	7.46	65.19	13.53	7.46	1.38	6.91	29.28
Victoria.....		42.23		9.28		3.03		0.38	2.84				7.20			1.14	74.43	10.80	6.06	3.03		19.89
Western Australia.....	0.34	30.81	0.17	12.74	1.38	3.62			3.79	0.34					0.17	4.99	58.35	11.19	3.62	4.82	7.05	26.68
Total for five Provinces..	1.39	34.42	0.40	9.50	1.03	2.42		0.72	3.23	0.27	0.18		2.02	0.36	0.53	5.29	61.76	10.09	4.39	2.87	3.36	20.71

Provinces.	Surface.								Surface (where surface mining is performed).					Total average.
	By fall of person.	By mine cars or mine locomotives.	By railway cars or locomotives.	By run or fall of ore in or from ore bins.	By boiler explosions.	By electricity (shock or burns).	By machinery.	By other causes.	By mill and smelting plant accidents.	Total, surface.	By falls or slides of rock or ore.	By explosives (includes premature blasts, flying pieces from blasts, etc.).	By other causes.		Total, surface (where surface mining is done).
	21	22	23	24	25	26	27	28	29		30	31	32	
British North America:										10.48	1.90		0.48	2.38
British Columbia.....	0.48	1.90	0.48			0.48	0.95	6.19		5.00				
Nova Scotia.....	2.21	3.47	1.89	0.32	1.26	2.21	4.10	8.20	23.98	1.89	0.32	1.26	3.47	3.47
Ontario.....	1.46	2.74	1.28	0.18	0.18	0.92	1.83	4.75	4.75	18.09	1.83	0.18	0.92	2.93
Total for three Provinces.....														
Australasia:										13.60	4.29	1.61	3.40	9.30
New South Wales.....	1.97	1.61		0.36	0.36	0.72	4.11	4.47		4.48	23.39	1.49	33.33	58.21
New Zealand.....	0.50	0.50					2.49	0.99		3.31	1.94	0.28		2.22
Queensland.....	0.55							2.76			5.68			5.68
Victoria.....						0.86	6.20	3.95	1.72	14.28	0.52		0.17	0.69
Western Australia.....	1.03	0.52												
Total for five Provinces.....	0.90	0.58		0.03	0.09	0.40	2.87	2.69	0.45	8.07	4.98	0.58	3.90	9.46

Countries.	Surface.								Surface (where surface mining is performed).									
	By fall of person.	By mine cars or mine locomotives.	By railway cars or loco- motives.	By run or fall of ore in or from ore bins.	By boiler explosions.	By electricity (shock or burns).	By machinery.	By mill and smelting plant accidents.	By other causes.	Total, surface.	By falls or slides of rock or ore.	By explosives (includes premature blasts, flying pieces from blasts, etc.).	By mine cars or loco- motives.	By steam shovels.	By falls of persons.	By other causes.	Total, surface (where surface mining is per- formed).	Grand total.
United States.....	29	175	2	18	3	5	197	492	399	1,320	22	29	49	24	12	22	158	7,652
British North America.....	26	16	5	.....	.....	.....	25	38	50	160	9	1	.....	.....	.....	1	11	907
Great Britain ^b.....	.....	382	.....	.....	11	4	348	.....	1,743	2,488	.....	.....	.....	.....	.....	.....	203	9,298
Australasia.....	82	73	.....	2	.....	5	330	10	1,173	1,675	86	15	2	8	6	86	.....	9,284
Cape Colony: Kimberley diamond mines.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	327	74	1,057	.....	30	438	1,926	3,052
Italy.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2,431
Total.....	137	646	7	20	14	14	900	540	3,365	5,643	444	119	1,108	32	48	547	2,298	32,624

^a Figures include only those States having mine-inspection service.^b Figures cover all mines included under the Metalliferous Mines Regulation Act.^c Figures include accidents from mine gases, powder fumes and gases, and mine fires.

TABLE 35.—Percentage of number of men injured in and about the principal metal and nonmetal (except coal) mines of the United States and certain foreign countries, 1894-1911, with injuries classified according to cause.

Countries	Underground.										Shaft.											
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total, underground.	17	18	19	20	Total, shaft.
	By fall of person, staking, etc.	By falling rock or ore from roof or wall.	By timber or hand tools.	By explosives (includes premature blasts, flying pieces from blasts, etc.).	By explosions of misfires, drilling into old bottoms, etc.	By suffocation from powder fumes, etc.	By thawing explosives.	By haulage accidents (by mine cars, etc.).	By falling down chute, winze, raise, slope, or mill hole, etc.	By run of ore from chute or pocket.	By drilling accidents (by machine or hand drills).	By electricity (shock or burns).	By haulage machinery, not including mine locomotives or machine drills).	By mine fires (burned, suffocated, etc.).	By intrusion of water.	By other causes.		By falling down shaft.	By objects falling down shaft.	By being struck or crushed by cages, skip, bucket, or hoist, etc.	By other causes.	
United States.....	4.43	28.65	2.36	7.06	3.34	0.52	0.31	4.98	2.68	1.53	3.65	0.07	0.48	0.16	.....	10.02	70.24	1.92	2.57	3.71	2.24	10.44
British North America.....	3.75	16.10	1.98	8.71	11.14	0.66	0.88	4.74	5.84	0.22	2.76	0.88	0.88	0.88	0.11	11.03	69.68	2.54	1.98	6.29	0.66	11.47
Great Britain.....	.....	16.67	.....	4.52	.....	0.01	.....	9.56	.....	.....	.....	0.02	2.19	0.11	0.01	35.36	68.65	0.97	1.24	0.63	1.75	4.59
Australasia.....	2.46	23.04	0.31	6.87	0.59	0.08	.....	2.38	1.86	0.21	0.38	0.01	2.40	0.04	0.10	27.06	67.79	2.26	2.79	1.94	4.99	11.98
Cape Colony, Kimberley dia- mond mines.....	2.03	17.53	.....	5.31	.....	0.03	.....	5.41	0.49	.....	0.03	0.03	0.20	.....	0.07	2.59	33.72	0.33	0.82	1.70	0.33	3.18
Italy.....	.....	43.93	.....	9.09	.....	18.72	.....	.....	.....	.....	.....	.....	.....	.....	.....	28.26	100.00	.....	.....	.....	.....	.....
Total average.....	2.03	23.39	0.70	6.31	1.26	1.56	0.10	5.21	1.37	0.43	1.04	0.03	1.46	0.11	0.04	22.84	67.88	1.47	1.88	1.94	2.49	7.78

Countries.	Surface.								Surface (where surface mining is performed).									
	By fall of person.	By mine cars or mine locomotives.	By railway cars or locomotives.	By run or fall of ore in or from ore bins.	By boiler explosions.	By electricity (shock or burns).	By machinery.	By mill and smelting plant accidents.	By other causes.	Total, surface.	By falls or slides of rock or ore.	By explosives (includes premature blasts, flying pieces from blasts, etc.).	By mine cars or locomotives.	By steam shovels.	By falls of person.	By other causes.	Total.	Total average.
	21	22	23	24	25	26	27	28	29		30	31	32	33	34	35		
United States.....	0.38	2.29	0.03	0.23	0.04	0.07	2.57	6.43	5.21	17.25	0.29	0.38	0.64	0.31	0.16	0.29	2.07	100.00
British North America.....	2.87	1.76	0.55	.....	.....	.....	2.76	4.19	5.51	17.64	0.99	0.11	.....	.....	.....	0.11	1.21	100.00
Great Britain ^b.....	.....	4.11	.....	.....	0.12	0.04	3.74	.....	18.75	26.76	.....	.....	.....	.....	.....	.....	.....	100.00
Australasia.....	0.88	0.79	.....	0.02	.....	0.05	3.56	0.11	12.63	18.04	0.93	0.16	0.02	0.09	0.06	0.93	2.19	100.00
Cape Colony, Kimberley diamond mines.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	10.72	2.41	34.64	.....	0.98	14.35	63.10	100.00
Italy.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	100.00
Total average.....	0.42	1.98	0.02	0.06	0.04	0.04	2.76	1.66	10.32	17.30	1.36	0.36	3.40	0.10	0.15	1.67	7.04	100.00

^a Figures include only those States having mine-inspection service.

^b Figures cover all mines included under Metalliferous Mines Regulation Act.

^c Figures include accidents from mine gases, powder fumes and gases, and mine fires.

TABLE 36.—Number of men injured in and about the principal metal and nonmetal (except coal) mines of the United States, a 1894-1911, with injuries classified according to cause.

States.	Underground.													Shaft.								
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total, underground.	17	18	19	20	Total, shaft.
	By fall of person, staking, etc.	By fall of rock or ore from roof or wall.	By timber or hand tools.	By explosives (includes premature blasts, flying pieces from blasts, etc.).	By explosions of misfires, drilling into old bottoms, etc.	By suffocation from powder fumes, etc.	By thawing explosives.	By haulage accidents (by mine cars, mine locomotives, breakage of rope, etc.).	By falling down chute, winze, raise, slope, or mill hole, etc.	By run of ore from chute or pocket.	By drilling accidents (by machine or hand drills).	By electricity (shock or burns).	By machinery (pumps, hoisting and haulage machinery, not including mine locomotives or machine drills).	By mine fires (burned, suffocated, etc.).	By intrusion of water.	By other causes.		By falling down shaft.	By objects falling down shaft.	By being struck or crushed by cage, skip, bucket, or hoist, etc.	By other causes.	
Colorado.....	306	1,629	150	286	201	37	21	307	148	108	270	5	18	2		618	4,106	91	146	196	132	565
Michigan:																						
Houghton County.....	3	53	6	32	13	1		2	2	5						16	133	11	8	16	9	44
Dickinson County.....	9	64	3	29	7			19	5		2		3	7		24	172	10	3	13		26
Iron County.....	1	2		1												17	21					
Total.....	13	119	9	62	20	1		21	7	5	2		3	7		57	326	21	11	20	9	70
Minnesota:																						
Missouri.....	7	59	2	17	1			15	6		1					12	120	5	4	3	3	15
Montana.....	10	134	3	109	12	2	2	4	1		1		9			20	307	22	33	27	20	102
Nebraska.....		174	11	47	14			16	33		3		4			36	340	5	5	2	19	5
Nevada.....	2	36	4	1	4			10	5	2	1		8	3		10	80	1	1	1		9
South Dakota.....	1	41	2	18	4		1	9	5		1					14	96	2		3	2	7
Grand total.....	339	2,162	181	540	256	40	24	381	205	117	279	5	37	12		767	5,375	147	197	284	171	799

States.	Surface.										Surface (where surface mining is performed).							
	By fall of person.	By mine cars or mine locomotives.	By railway cars or locomotives.	By run or fall of ore in or from ore bins.	By boiler explosions.	By electricity (shock or burns).	By machinery.	By mill and smelting plant accidents.	By other causes.	Total, surface.	By falls or slides of rock or ore.	By explosives (includes premature blasts, flying pieces from blasts, etc.).	By mine cars or locomotives.	By steam shovels.	By falls of person.	By other causes.	Total, surface (where surface mining is performed).	Grand total.
Colorado.....	23	149	.....	18	2	5	175	492	371	1,235	30	31	32	33	34	35	.....	5,906
Michigan:																		
Houghton County.....		11	1				8		4	4	1		1				2	181
Dickinson County.....									10	30	1							230
Iron County.....																		21
Total.....		11	1	1			8		14	34	1	.....	1	24	12	22	2	432
Minnesota.....	5	14	1				6		11	37	20	28	48	24	12	22	154	326
Missouri.....																		422
Montana.....		1			1		8		3	13								371
Nevada.....												1					1	91
South Dakota.....	1									1	1						1	104
Grand total.....	29	175	2	18	3	5	197	492	394	1,320	22	29	49	24	12	22	158	7,652

^a Figures include only those States having mine-inspection service.

TABLE 37.—Percentage of number of men injured in and about the principal metal and nonmetal (except coal) mines of the United States, a 1894-1911, with injuries classified according to cause.

States.	Underground.										Shaft.											
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total, underground.	17	18	19	20	Total, shaft.
	By fall of person, staking, etc.	By fall of rock or ore from roof or wall, fall or cave of ground.	By timber or hand tools.	By explosives (includes premature blasts, flying pieces from blasts, etc.).	By explosions of mines, drilling into old bottoms, etc.	By suffocation from powder fumes, etc.	By thawing explosives.	By haulage accidents (by mine cars, etc.).	By falling down chutes, winze, raise, slope, or mill hole, etc.	By run of ore from chute or pocket.	By drilling accidents (by machine or hand drills).	By electricity (shock or burns).	By machinery (pumps, hoisting and mine locomotives or machine drills).	By mine fires (burned, suffocated, etc.).	By intrush of water.	By other causes.		By falling down shaft.	By objects falling down shaft.	By being struck or crushed by cage, skip, bucket, or hoist, etc.	By other causes.	
Colorado.....	5.18	27.58	2.54	4.84	3.40	0.63	0.36	5.20	2.51	1.83	4.57	0.08	0.30	0.03	.....	10.47	69.52	1.54	2.47	3.32	2.24	9.57
Michigan:																						
Houghton County.....	1.66	29.28	3.31	17.68	7.18	0.55	.....	1.11	1.11	2.76	0.86	.....	1.31	3.04	.....	8.84	73.48	6.08	4.42	8.84	4.97	24.31
Dickinson County.....	3.91	27.83	1.31	12.61	3.04	.....	.....	8.26	2.17	.....	.....	.....	.....	.....	.....	10.44	74.78	3.55	1.31	5.65	.....	11.31
Iron County.....	4.76	9.53	.....	4.76	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	80.95	100.00	.....	.....	.....	.....	.....
Total.....	3.01	27.55	2.08	14.35	4.63	0.23	.....	4.86	1.62	1.16	0.46	.....	0.69	1.62	.....	13.20	75.46	4.86	2.55	6.72	2.08	16.21
Minnesota:																						
Missouri.....	2.15	18.10	0.61	5.21	0.31	.....	.....	4.60	1.84	.....	0.31	.....	2.13	.....	.....	3.68	36.81	1.53	1.23	0.92	0.92	4.60
Missouri.....	2.37	31.76	0.71	25.83	2.84	0.47	0.47	0.95	0.24	.....	0.24	.....	.....	.....	.....	4.74	72.75	5.21	7.82	6.40	4.74	24.17
Montana.....	.....	46.90	2.96	12.67	3.77	.....	.....	4.31	8.90	0.54	0.81	.....	1.08	.....	.....	9.70	91.64	1.35	0.54	5.12	1.35	8.36
Nevada.....	2.20	39.56	4.39	1.10	4.39	.....	.....	9.89	5.49	2.20	1.10	.....	3.30	3.30	.....	10.99	87.91	1.10	1.10	7.69	.....	9.89
South Dakota.....	0.96	39.43	1.92	17.31	3.85	.....	0.96	8.65	4.81	.....	0.96	.....	.....	.....	.....	13.46	92.31	1.92	2.89	1.92	.....	6.73
Total average.....	4.43	28.65	2.36	7.06	3.34	0.52	0.31	4.98	2.68	1.53	3.65	0.07	0.48	0.16	.....	10.02	70.24	1.92	2.57	3.71	2.24	10.44

States.	Surface.										Surface (where surface mining is performed).							
	By fall of person.	By mine cars or mine locomotives.	By railway cars and locomotives.	By run or fall of ore in or from ore bins.	By boiler explosions.	By electricity (shock or burns).	By machinery.	By mill and smelting plant accidents.	By other causes.	Total.	By falls or slides of rock or ore.	By explosives (includes premature blasts, flying pieces from blasts, etc.).	By mine cars or locomotives.	By steam shovels.	By falls of person.	By other causes.	Total, surface (where surface mining is performed).	Total average.
	21	22	23	24	25	26	27	28	29	Total.	30	31	32	33	34	35		100.00
Colorado.....	0.39	2.53		0.30	0.03	0.08	2.97	8.33	6.28	20.91								100.00
Michigan:																		100.00
Houghton County.....									2.21	2.21	0.43		0.43				0.86	100.00
Dickinson County.....		4.79	0.43				3.48		4.35	13.05								100.00
Iron County.....																		100.00
Total.....		2.55	0.23				1.85		3.24	7.87	0.23		0.23				0.46	100.00
Minnesota.....	1.53	4.30	0.31				1.84		3.37	11.35	6.14	8.59	4.72	7.36	3.68	6.75	47.24	100.00
Missouri.....		0.24			0.24		1.89		0.71	3.08								100.00
Montana.....																		100.00
Nevada.....	1.10									1.10	0.96	1.10					1.10	100.00
South Dakota.....																	0.96	100.00
Total average.....	0.38	2.29	0.03	0.23	0.04	0.07	2.57	6.43	5.21	17.25	0.29	0.38	0.64	0.31	0.16	0.29	2.07	100.00

^a Figures include only those States having mine-inspection service.

TABLE 38.—Number of men injured in and about the principal metal and nonmetal except coal mines of British North America and other foreign countries, 1894-1911, with injuries classified according to cause.

Countries.	Underground.										Shaft.											
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total, underground.	17	18	19	20	Total, shaft.
	By fall of person, staging, etc.	By fall of rock or ore from roof or wall, fall or cave of ground.	By timber or hand tools.	By explosives (includes premature blasts, flying pieces from blasts, etc.).	By explosions of mishaps, drilling into old bottoms, etc.	By suffocation from powder fumes, etc.	By thawing explosives.	By mine accidents (by mine cars, mine locomotives, breakage of ropes, etc.).	By falling down chute, winze, raise, slope, or mill hole, etc.	By vein of ore from chute or pocket.	By drilling accidents (by machine or hand drills).	By electricity (shock or burns).	By machinery (pumps, hoisting and haulage machinery, not including mine locomotives or machine drills).	By mine fires (burned, suffocated, etc.).	By burst of water.	By other causes.	Total, underground.	By falling down shaft.	By objects falling down shaft.	By being struck or crushed by cage, skip, bucket, or hoist, etc.	By other causes.	Total, shaft.
British North America:																						
British Columbia.....	25	11	16	27	41	.....	1	26	.....	1	16	.....	5	.....	1	68	349	2	1	30	5	41
Nova Scotia.....	.....	3	.....	1	.....	.....	.....	.....	3	.....	1	.....	.....	.....	.....	.....	8	3	1	2	.....	6
Ontario.....	9	39	2	51	60	6	7	17	22	1	8	.....	3	8	.....	32	275	18	13	25	1	57
Total.....	34	146	18	79	101	6	8	43	53	2	25	2	8	8	1	100	632	23	18	57	6	104
Great Britain ^a.....	.....	1,540	420	.....	.....	1	.....	889	.....	.....	.....	2	263	10	1	3,207	6,283	90	115	59	163	427
Australasia:																						
New South Wales.....	92	351	37	96	29	5	.....	82	16	8	25	1	9	4	8	93	908	38	28	42	3	111
New Zealand.....	8	24	1	21	8	.....	.....	5	.....	1	.....	.....	4	.....	5	126	216	3	1	6	.....	10
Queensland.....	129	615	5	183	13	.....	.....	91	13	2	13	.....	63	.....	2	499	1,625	33	109	42	127	311
Victoria.....	.....	540	.....	135	.....	.....	.....	11	103	10	.....	.....	177	.....	.....	291	1,269	101	93	62	.....	266
Western Australia.....	12	613	3	295	6	2	.....	6	8	.....	.....	.....	3	.....	.....	1,527	2,384	38	36	33	331	441
Total.....	232	2,183	11	611	56	7	.....	258	171	20	38	1	226	4	15	2,533	6,402	213	297	185	161	1,129
Cape Colony, Kimberley diamond mines.....	62	535	.....	162	.....	1	.....	165	15	.....	1	1	6	.....	2	79	1,029	10	25	52	10	97
Italy.....	.....	1,068	.....	221	.....	3,455	.....	.....	.....	.....	.....	.....	.....	.....	.....	687	2,431	.....	.....	.....	.....	.....

Countries.	Surface.								Surface (where surface mining is performed)								Grand total.	
	By fall of person.	By mine cars or mine locomotives.	By railway cars and locomotives.	By run or fall of ore in or from ore bins.	By boiler explosions.	By electricity (shock or burns).	By machinery.	By mill and smelting plant accidents.	By other causes.	Total, surface.	By falls or slides of rock or ore.	By explosives (includes premature blasts, flying pieces from blasts, etc.).	By mine cars or locomotives.	By steam shovels.	By falls of person.	By other causes.		Total, surface (where surface mining is performed).
British North America:	21	22	23	24	25	26	27	28	29	41	30	31	32	33	34	35		
British Columbia.....	10	7	2				7		15	41								431
Nova Scotia.....	16	9	3				18	38	35	119	9	1				1	11	14
Ontario.....	26	16	5		11	4	25	38	50	160	9	1						462
Total.....	382	32	5				348		1,713	2,488								907
Great Britain ^a	76	69		2		5	70	8	132	362	24	13			5	18	60	1,441
Australasia:	2	3					12		10	27	12	4		8		67	91	344
New South Wales.....	1	1					40	2	223	267	5	3				3	11	2,214
New Zealand.....							228		800	1,032	46	1			1		46	1,571
Queensland.....																		46
Victoria.....																		46
Western Australia.....	4																2	3,859
Total.....	83	73		2		5	350	10	1,165	1,638	87	21		8	6	88	210	9,499
Cape Colony, Kimberley diamond mines.....											327	74	1,057		30	138	1,926	3,052
Italy.....																		2,431

^a Figures cover all mines included under Metalliferous Mines Regulation Act.

^b Includes mine fires, mine gases, and powder fume, etc.

TABLE 39.—Percentage of men injured in and about the principal metal and nonmetal (except coal) mines of British North America and other foreign countries, 1894-1911, with injuries classified according to cause.

Countries.	Underground.										Shaft.											
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total, underground.	17	18	19	20	Total, shaft.
	By fall of person, staging, etc.	By falling rock or ore from roof or wall.	By timber or hand tools.	By explosives (includes premature blasts, flying pieces from blasts, etc.).	By explosions of misfires, drilling into old bottoms, etc.	By suffocation from powder fumes, etc.	By thawing explosives.	By handling accidents (by mine cars, etc.).	By falling down chute, winze, raise, slope, or mill hole, etc.	By run of ore from chute or pocket.	By drilling accidents (by machine or hand drills).	By electricity (shock or burns).	By machinery (pumps, hoisting and haulage machinery, not including mine locomotives or machine drills).	By mine fires (burned, suffocated, etc.).	By rush of water.	By other causes.		By falling down shaft.	By objects falling down shaft.	By being struck or crushed by cage, skip, bucket, or hoist, etc.	By other causes.	
British North America:																						
British Columbia.....	5.80	21.82	3.71	6.27	9.51		0.23	6.03	6.50	0.23	3.71		1.16		0.23	15.78	80.98	0.46	0.93	6.96	1.16	9.51
Nova Scotia.....		21.43		7.14	12.99			21.43	21.43		7.14						57.14	21.43	7.14	14.29		42.86
Ontario.....	1.95	10.61	0.43	11.04		1.30	1.51	3.70	4.76	0.21	1.73		0.65	1.73		6.92	59.53	3.90	2.81	5.41	0.21	12.34
Total.....	3.75	16.10	1.98	8.71	11.14	0.66	0.88	4.74	5.84	0.22	2.76	0.02	0.88	0.88	0.11	11.03	69.68	2.54	1.98	6.29	0.66	11.47
Great Britain <i>a</i>		16.67		4.52		0.01		9.56					2.19	0.11	0.01	35.56	68.65	0.97	1.24	0.63	1.75	4.59
Australasia:																						
New South Wales.....	6.38	26.44	2.22	6.66	2.01	0.35		5.69	3.19	0.56	1.73	0.07	0.62	0.28	0.56	6.25	63.01	2.64	1.94	2.91	0.21	7.70
New Zealand.....	2.33	9.88	0.29	6.11	2.33			1.45	1.16				1.16		1.45	36.63	62.79	0.87	0.29	1.75		2.91
Queensland.....	5.42	27.78	0.22	8.40	0.59	0.13		4.25	0.59	0.09	0.59		2.84		0.09	22.54	73.40	1.49	4.92	1.90	5.73	14.04
Victoria.....		34.37		8.59				2.61	6.56	0.64			9.36			18.52	80.78	6.43	5.92	3.95		16.30
Western Australia.....	0.31	15.89	0.08	5.34	0.16			0.16	0.21				0.08			39.55	61.78	0.99	0.93	0.86		11.43
Total.....	2.46	23.15	0.42	6.83	0.59	0.07		2.42	1.85	0.21	0.40	0.01	2.40	0.04	0.16	26.88	67.89	2.26	2.83	1.96	4.92	11.97
Cape Colony, Kimberley diamond mines.....	2.03	17.53		5.31		0.03		5.41	0.49		0.03	0.03	0.20		0.07	2.59	33.72	0.33	0.82	1.70	0.33	3.18
Italy.....		43.93		9.09		18.72										28.26	100.00					

Countries.	Surface.								Surface (where surface mining is performed).								Total average.	
	By fall of person.	By mine cars or mine loco- motives.	By railway cars or loco- motives.	By run or fall of ore in or from ore bins.	By boiler explosions.	By electricity (shock or burns).	By machinery.	By mill and smelting plant accidents.	By other causes.	Total, surface.	By falls or slides of rock or ore.	By explosives (includes premature blasts, flying pieces from blasts, etc.).	By mine cars or loco-mo- tives.	By steam shovels.	By falls of persons.	By other causes.		Total, surface (where sur- face mining is performed).
British North America: British Columbia. Nova Scotia. Ontario. Total. Great Britain ^a .	21	22	23	24	25	26	27	28	29	Total, surface.	30	31	32	33	34	35	Total, surface (where sur- face mining is performed).	
	2.33	1.62	0.46				1.62		3.48	9.51								
	3.46	1.95	0.65				3.91	8.24	7.65	25.76	1.95	0.21				0.21	2.37	
	2.87	1.76	0.55		0.12	0.04	2.76	4.19	5.51	17.04	0.99	0.11				0.11	2.21	
		4.11					3.74		18.75	26.76								
Australasia: New South Wales. New Zealand Queensland Victoria. Western Australia. Total. Cape Colony, Kimberley diamond mines. Italy.		5.27	4.79	0.14		0.35	4.85	0.56	9.16	25.12	1.67	0.90			0.35	1.25	4.17	
		0.58	0.87				3.49		2.91	7.85	3.49	1.16		2.33		19.47	26.45	
		0.05	0.05				1.80	0.09	10.07	12.06	0.22	0.14				0.14	0.50	
											2.92						2.92	
		0.10					5.91		20.73	26.74		0.03			0.03		0.06	
		0.88	0.78	0.02		0.05	3.71	0.11	12.36	17.91	0.93	0.22		0.08	0.06	0.94	2.23	
											10.72	2.41	34.64		0.98	14.35	63.10	

^a Figures cover all mines included under the Metalliferous Mines Regulation Act.

^b Includes mine fires, mine gases, powder fumes, etc.

CHAPTER IX.

INSPECTION SYSTEMS MAINTAINED BY MINING COMPANIES.

By L. O. KELLOGG.

In Chapter II of this report brief mention is made of the fact that most of the important mining companies have adopted or are adopting private systems of inspection, and that this action is largely the result of former reports by the committee making this report. The committee feels that the commonwealth is the unit best fitted to obtain adequate inspection of mines, and therefore its principal work has been to draft a practicable and efficient set of regulations and provisions for inspection which should serve as a model for legal enactment by the several metal-mining States. It recognizes, however, that State laws and State inspection are not the only means available or desirable for obtaining a proper degree of safety in the mining industry. If American metal mining is to clear itself of the disgrace of the high accident and death rates existing, the several agencies must cooperate. State regulation ought to be and must be supplemented by work on the part of each operator. Nobody knows better than the operator the risks present in his own mine and nobody is in so favorable a position to eliminate such risks.

The promotion of safety is receiving greater and greater attention at the hands of the mining companies as the fact becomes more widely known that the existing conditions are not what they should be and that they can be changed. The employers' liability or workmen's compensation laws, which are becoming more and more general, tend to stimulate interest in safety work, largely because such work then becomes financially worth while. Without such laws the employer is engaged not so much in reducing the number of accidents as in trying to reduce the amount of the payment to the sufferer after the accident has occurred. Yet his payments are probably as large as under an equitable compensation law, or larger, as both he and his workmen are the prey of unscrupulous intermediaries. With compensation fixed by law in all cases, however, the cost of accidents becomes a definite charge against operations, and the employer can apply himself to its reduction as he would to the reduction of any other

cost. This financial consideration is second only to the instincts of ordinary humanity as an incentive urging the mining companies to undertake safety work.

The establishment of company inspection systems has become so common as to make it quite impossible to describe them all. The systems of three different companies have been selected as typical of three phases of the mining industry and as representing, each in its own class, probably the highest development of systematic inspection. The Beaver Consolidated Mines (Ltd.) operates in Cobalt, Ontario, Canada, a property that is typical of the small mine; the Treadwell group, on Douglas Island, Alaska, although nominally owned by three companies, is operated really as one property, and is an excellent representative of the single large mine; the Cleveland-Cliffs Iron Co. operates a number of detached and rather widely separated mines in the Marquette district of Michigan, and is taken as the example of the large company with extensive interests.

INSPECTION AT BEAVER CONSOLIDATED MINES.

In respect to the thoroughness and success of its safety efforts, the Beaver Consolidated Mines (Ltd.) is perhaps the most interesting on the continent. The following description of its inspection system is taken from an account published in the *Engineering and Mining Journal* of August 17, 1912:

The Beaver system is due to an earnest desire on the part of its president and general manager, Frank L. Culver, to protect its employees from all unnecessary dangers of mine work. Mr. Culver became impressed with the merits of mine inspection by the company itself and appointed an inspector. The report of the inspector made it evident that many improvements in the condition of the mine were necessary. Mr. Culver, at the outset, solved the most important question relative to mine inspection, the authority and power to be vested in the inspector, by giving the inspector at the Beaver power to issue orders to any department, to make any repairs or changes he deemed necessary for the safety of the men, or to discharge anyone failing to comply with the rules or regulations of the inspection department; he is responsible only to the superintendent. No matter how competent the official or how excellent the rules and work of any department, the greatest efficiency and best results can not be obtained unless its orders are obeyed. This is particularly true with inspection work, which is apt to meet with opposition from heads of departments and other subofficials. The work at the Beaver has met with a hearty cooperation of the entire organization, and all are interested in keeping the workings in a safe condition and enforcing the rules and regulations of the inspection department.

The Beaver No. 1 shaft in 1912 was about 600 feet in depth and the lowest working level 530 feet. No. 2 shaft, about 300 feet from No. 1, was connected at a depth of 200 feet with workings from No. 1. The property hoisted approximately 35,000 tons of ore per year and employed between 130 and 140 men.

Form No. 1, a sheet 17 by 10 inches, is a mine-inspection report filled out by the inspector twice every 24 hours. [A sample report is given below.] The data and names in the form are, of course, fictitious.

MINE-INSPECTION REPORT.

Day shift.

March 9, 1913.

SHAFTS, WINZES, RAISES.

Holes fired.....	17.
Holes refired.....	3.
Total holes fired.....	20.
Missed holes.....	None.
Timber.....	Stull in winze 405 needs bracing.
Blocking.....	O. K.
Ladders.....	Rungs broken on ladder No. 2, raise 405.
Pipe lines.....	O. K.
Signal lines.....	Short circuit, 300-foot station.
Cables.....	O. K.
Cages.....	Cage needs 21 new floor boards.
Chairs and gates.....	O. K.
Pumps.....	O. K.
Hoists.....	O. K.
Scaling.....	701 station, loose rock.
Machines.....	All in good repair.

DRIFTS, X-CUTS.

Holes fired.....	64.
Holes refired.....	None.
Total holes fired.....	64.
Missed holes.....	None.
Machines.....	All in good repair.
Pipe lines.....	O. K.
Tracks.....	O. K.
Cars.....	No. 28, axle broken.
Lights.....	O. K.
Tools.....	O. K.

STOPES.

Holes fired.....	38.
Holes refired.....	2.
Total holes fired.....	40.
Missed holes.....	None.
Machines.....	All in good repair.
Scaling.....	605 No. 1 stope, loose rock.
Pipe lines.....	O. K.
Manways.....	O. K.
Ladders.....	405 stope, rung broken.
Chutes.....	O. K.
Timber.....	O. K.
Sand blasts and block holes.....	3.

POWDER MAGAZINE.

Powder.....	240 pounds cheddite, 30 pounds dynamite.
Fuse.....	800 feet.
Caps.....	95 detonators, No. 8.

GENERAL REMARKS.

.....

.....

J. JOHNSON, *Inspector.*

J. SMITH, *Outgoing shift boss.*
H. BROWN, *Incoming shift boss.*
W. JONES, *Captain.*

Two 10-hour shifts are worked at the mine and the inspector is on duty from 5 to 9.30 a. m. and from 5 to 9.30 p. m. All miners coming off shift report to him and all machine-drill men, in order to get credit for a shift's work, have to report their time and make a blasting report, stating the number of missed holes in their working place. All men reporting missed holes are required to return and fire them before leaving shift. This is done in the belief that the man drilling the holes, being more familiar with the face, as drilled, is less likely to meet with an accident than the man following on the next shift; this is certainly true, and such a procedure is a good safeguard against a common cause of serious accidents.

Under the heading "Timber," in the divisions of "Shafts, Winzes, Raises," and of "Stopes," any repairs to timbering or new timbers to be placed immediately to insure safety are noted. Any repairs made to cables, cages, hoists, machines, etc., are noted opposite these headings. This report is signed by the inspector, mine captain, and outgoing and incoming shift bosses, which is sufficient to show that all are advised of the condition of the works and machinery.

Form No. 2 is a sheet $8\frac{1}{2}$ by $5\frac{1}{2}$ inches, and is used as an order by the inspector, to either the mine captain, master mechanic, or carpenter, as the case may be, to have any repairs made as indicated by the mine-inspection report. The person to whom this order is made is required to state the time when repairs were made and to sign three copies of the order, one for the mine office, one for the inspector, and one for his own record. The superintendent sees that all such orders are obeyed. [A sample report is given below.]

INSPECTOR'S REPORT.

To *Carpenter*:

Date, *March 9/13.*

405 No. 21 raise, 405 stope, 21 new rungs needed in each ladder, 21 new boards needed in cage.

Time reported, *10 a. m., J. Johnson*, Inspector.

Time attended to, *2 p. m., 9/3/13*, by *J. Raffles*, (Signature).

Remarks: Will repair cage between shifts.

The men are lowered and raised on a cage, not over 10 being allowed on the cage at one time. A Stephen Humble hook to prevent overwinding has been installed at the shaft house, and the cages are equipped with dogs to prevent any sudden drop. The safety devices and cables are tested regularly to insure that they are in good working order. It is the duty of the cage tender, before starting with men on the cage, to warn all to keep arms and body clear of timbers. Shafts are also provided with manways in case hoists are out of commission.

An electric signal system for hoisting is operated direct from the electric-power current without the aid of batteries. The wires are lead covered to protect them from moisture, and as no batteries are used there is little danger of the system getting out of commission. In case the hoisting engineer fails to understand any signal he rings a bell for signals to be repeated. All rock hoisted is brought up in cars on cages, and to guard against a rock falling into the shaft the cars are never filled to the top. The danger from mine fires is slight, owing to the small amount of timber used in the mine, other than shaft timbers, which are usually so wet that there is little danger of their getting on fire. In case of fire, shaft No. 2 could be used as an exit for the men.

The Ontario mine laws permit only a 24-hour supply of explosives to be stored underground, and this is all that the company keeps in the mine. The underground magazine is in a drift some distance from the rest of the workings, and the storage magazine on surface is situated quite a distance from the works. An emergency case is kept at the mine office for the treatment of wounds, and if needed a doctor is called at once in case of accidents.

The Beaver company has also recently introduced a device to reduce the danger resulting from lack of acquaintance with the English

language. It consists in the use of a red flag to indicate dangerous conditions. Specifically, in the case of misfires, known or suspected, a red flag is placed at the entrance to the working and everyone passing, whether he be a foreigner and non-English speaking or not, at once recognizes this universal danger sign and proceeds cautiously. A reversion to the sign language, such as this, might be followed in other particulars of mining operations and the hazard attendant on the increasing employment of foreign labor thus largely neutralized.

EFFICIENCY OF SYSTEM.

Before the system of inspection was started at the Beaver mine there were several serious accidents. Since the system has been in force, however, there have been no fatal accidents, and only five of any consequence whatever up to June, 1914. Of these the most serious was a broken arm. In every case the accident was the result of carelessness on the part of the man himself. The company took care of the injured men and compensated them for the time lost. As a measure of the minor nature of these five accidents, and also of the economy of operating with due regard to safety precautions, it may be noted that the greatest compensation the company had to pay in any one case was \$50, and the total was only \$192.

The average number of men on the Beaver pay roll since the inspection system was started is 135. The average number of days worked in a year is 315. This amounts to 42,500 man shifts per year. The five accidents mentioned occurred in a period of three years. The total number of man shifts in this time was 127,500. Assuming that the injuries come within the "serious" class, the rate is about 11.7 per 300,000 man shifts, or, as it is more commonly put, per 1,000 employees per year, reduced to the 300-day basis. A comparison of this figure with those presented in Technical Paper 61^a will show how well the inspection system works at the Beaver. Table 16 of that paper gives the average serious-injury rate for all United States mines except coal, in 1912, as 27.85 per 300,000 man shifts. To be sure, the number of men on the pay roll at the Beaver mine is probably somewhat greater than the number actually at work, but, on the other hand, the five accidents that occurred would barely come within the limits of "serious" accidents as defined in the paper mentioned, and it is probable that the figures used therein were also for the greater part based on the pay roll rather than on the number of men actually at work.

INSPECTION AT MINES OF CLEVELAND-CLIFFS IRON CO.

No company has taken a keener interest in the work of promoting mine safety than has the Cleveland-Cliffs Iron Co. For several years

^a Fay, A. H., Metal-mine accidents in the United States during the calendar year 1912: Technical Paper 61, Bureau of Mines, 1914, p. 70.

this company has carried on an energetic campaign to reduce the death rate from accidents, and to this end an elaborate inspection system was evolved and is in force, which places authority and responsibility in committees rather than in a single inspector. These include: A central safety committee, the final authority; an accident committee consisting of three superintendents; temporary committees of mine foremen; and temporary committees of workmen; besides these there is the permanent mine inspector. The following description of the system is taken from a paper by William Conibear, presented at the meeting of the Lake Superior Mining Institute, August, 1912:

The central safety committee consists of the mine superintendents of the company in Marquette County, the head mining captain, the master mechanic, the assistant auditor, the secretary of the pension department, the safety inspector, and, ex officio, the agent of the company. This committee meets monthly and acts as a legislative body on all safety recommendations which may have been offered by the foremen's committee, the workmen's committee, or the safety inspector, and to the application of which objection may have arisen. A majority decision is reported to the agent as the voice of the committee, and after his approval must be enforced. A question of importance thus decided may be embodied in a new rule and put forth as such. This committee also receives reports of all accidents occurring during the previous month and classifies them by causes.

The accident committee of three superintendents is of less importance. Its function is to investigate all fatal accidents and make a report to the agent of the company.

The foremen's committee is appointed periodically to make an inspection of all the company's workings, after which it is discharged, a new committee being appointed for the next inspection. The committee consists of three foremen from different mines of the company. It is instructed directly by the agent, and each member receives a copy of a series of questions; the ascertaining of the proper answers to these questions constitutes the inspection. The questions are about 170 in number and cover all details of the mining work, including the condition as regards safety of the property under inspection, the precautions against accidents, the preparations for coping with accidents, etc. The mine inspector accompanies the committee on its tour of inspection in the capacity of secretary. He has no voice in its decisions but makes out its report, which is, however, carefully reviewed by the members of the committee before submitting to the agent. The foremen regard it as a special favor to be allowed to serve on this committee and evince the keenest interest in the work of inspection.

Workmen's committees are similarly appointed for the various mines, differing in that each confines its inspection to its own mine. They also consist of three members, and it is attempted always to get men of various nationalities in order to attract the attention of the many foreigners, a difficult task unless one of their own countrymen is appointed to serve. They are required to approve the working of their mines or to offer suggestions for changes. The mine inspector also serves with them as with the foremen's committees. After one inspection they are discharged.

The safety inspector himself has actual charge of the safety department. His duty is to inspect all working places and submit his reports to the agent. He is required to report dangerous conditions and makes his inspections unannounced, so that the mines must be kept in condition for inspection at all times.

The committee system of inspection has many excellent features, especially for a large company managing several mines. Its two prin-

cial advantages would seem to be the wide appeal to the whole working force, got by appointing different committee members for each inspection; and the promotion of emulation among the several properties as the result of the reciprocal inspections by the foremen.

Mention of the source from which the description of this system was obtained, namely, the papers of the Lake Superior Mining Institute, suggests the propriety of noting the strong interest that this organization has always taken in the mine-safety movement. In addition to the paper noted, no less than 10 papers bearing on the question of mine safety and social conditions have been published by the institute, beginning in 1895, a very creditable record.

INSPECTION AT THE TREADWELL GROUP.

The Treadwell group puts the control of its safety work in the hands of a committee of 15 members. Eight of these are appointed by the Alaska Labor Union and seven by the superintendent of the group. The Treadwell group consists of three companies—the Alaska Treadwell, the Alaska United, and the Alaska Mexican. Four mines are operated, however, namely, the Treadwell, the 700-Foot, the Ready Bullion, and the Mexican. From each of these four mines the labor union selects two members of the underground crew. The superintendent's appointments consist of the assistant superintendent, who acts as chairman of the committee, one millman, one mechanic, and four men taken at large from either the surface works or underground. When any member resigns or is dropped out for cause, his place is filled from the same mine or part of the plant and in the same manner in which he was appointed originally.

The committee meets once a month and is empowered to select an inspector and a secretary. The inspector, under the direction of the committee, inspects all machinery, and the secretary records the transactions at the meetings and makes out reports thereof for each committee member. Each committee member receives \$5 for each regular monthly meeting which he attends, and if he is absent from two consecutive meetings without being previously excused he is dropped from the committee.

This committee is subdivided into five subcommittees, of three members each, which are required to examine into each individual accident and study its causes and then to formulate recommendations for the prevention of similar or any other accidents. The first subcommittee investigates underground accidents at the Treadwell; the second, those at the 700-Foot; the third, those at the Mexican; the fourth, those at the Ready Bullion; and the fifth, all surface accidents.

The transactions of these subcommittees are recorded by the secretary and copies made for each of the 15 members of the main committee, so that at the regular monthly meetings of the main committee intelligent discussion and study may result.

The committee of 15 has also adopted a schedule of benefits to be paid in case of death or accidents of various kinds, the amount of compensation varying with the severity of the accident, particularly as regards permanent disability or, in case of death, with the number of dependents and their relation to the deceased.

EFFICIENCY OF COMMITTEE SYSTEM.

In practice the efficiency of the subcommittees has been given close attention, with the result that prompt and complete investigations and reports of individual accidents are made. When an accident occurs, the members of the committee in charge of that part of the property are at once notified by telephone or messenger, and, going to the place of the accident, make an investigation while the facts are still fresh in the minds of the witnesses. A preliminary report is usually made within an hour after the accident happens. The fact that the committee members are actually employed in the places where accidents happen helps greatly in keeping the working places safe and also in getting accurate reports of accidents. The employees have learned that the committee takes steps to remedy dangerous conditions and consequently report freely any such that come to their attention.

REPORTS BY EMPLOYEES.

In addition to the work of this safety committee, an elaborate system of reports is maintained, the reports being made and signed by the men in charge of the various units, such as hoists and stopes. For instance, at the Mexican mine a report is made by the foreman on the condition of man-cage safety devices, sheave, and cable. The inspection is made three times each week and the name of the man making the inspection noted, the condition in which the apparatus was found, what steps were taken to remedy defects if any were found, etc. The hoisting engineers report who was on duty for each shift; whether the rope was tarred, changed, or reversed; whether the sheave or idlers were changed; the condition of the latter, etc. The watchman makes a report of any irregularities in any department he visits. Other reports are made in great detail.

While this system in general is giving excellent satisfaction, it is understood that certain changes are being made in some details.

CHAPTER X.

CHRONOLOGY OF RECENT IMPORTANT ACCIDENTS.

By W. R. INGALLS and L. O. KELLOGG.

In this chapter is given a chronological list, with brief descriptions, of some of the more important metal-mine accidents of recent years. The list makes no pretense to being complete, although it is believed that few serious accidents are omitted. A period of five years is covered, beginning with 1909; in addition one important accident of 1907 is included. The list covers primarily the United States only, but some of the disastrous accidents of other countries are noted. It is believed that this list represents very fairly the general run of accidents that may be expected in mining practice. It should be stated, however, that whereas the accidents listed here have usually resulted in the death of several men, the greatest number of deaths in the industry occur one at a time.

LIST OF METAL-MINE ACCIDENTS.

1907.

December 4, a caving of the Alpha shaft of the Giroux company near Ely, Nev., killed two men and imprisoned three others, who were rescued 46 days later.

1909.

March 3, a round of shots exploded prematurely in the shaft bottom at the Diamond mine, Butte, Mont., killing four men.

April 22, a cave-in at the M. & B. mine, Duenweg, Mo., killed three men.

September 25, the caving of the Hampton stope under the Combination 20-stamp mill of the Goldfield Consolidated, Goldfield, Nev., killed three men and ruined the mill.

November 29, a fire at the London mine of the Tennessee Copper Co. destroyed the shaft house, the imprisoned men being safely rescued.

1910.

March 2, an explosion of a powder magazine in the Alaska Mexican mine, Treadwell, Alaska, killed 37 men.

April 14, seven men were killed in Santa Gertrudis mine, Pachuca, Mexico, by the explosion of a compressed air receiver in such manner as to allow discharge of noxious products through the air line into the mine.

April 24, a cave-in at the Camelia mine, Pachuca, Mexico, killed seven miners.

June 7, five men were killed by falling from car at Richmond mine of Thomas Iron Co., Dover, N. J.

October 8, five men were killed by a run of broken ore in the Sirena mine, Guanaajuato, Mexico.

1911.

January 14, an underground fire occurred in the workings between the Modoc and the Butte-Ballaklava mines, Butte, Mont.; two men were smothered.

January 18, a powder explosion in the Keating mine, Broadwater County, Mont., killed six men and injured two others, wrecking the shaft.

February 23, a fire in the Belmont mine, Tonopah, Nev., resulted in the death of 17 men.

March 11, a slide of bank at the Norman mine of the Oliver Iron Mining Co., Virginia, Minn., killed 14 men.

May 4, two men were killed and one injured by a premature explosion in the Moonlight tunnel of the Ajax Mining Co., Burke, Idaho.

May 5, seven men were killed by a fire in the Hartford mine of the Republic Iron & Steel Co., Negaunee, Mich.

August 19, a slide of bank occurred at the open pit of the Buffalo-Susquehanna mine in Hibbing on the Mesabi range, Minn., where stripping was being conducted by contractors; 3 men were killed and 21 injured.

August 23, a fire at the new shaft of the Giroux Co., Ely, Nev., resulted in seven deaths and in damage to the shaft.

September 3, six men were killed in a cage accident at the Butte & Superior mine, Butte, Mont.

September 4, two miners were killed and one injured in a hoisting accident at the Red Jacket shaft of Calumet & Hecla, Calumet, Mich.

September 4, two men were drowned in a cage which was lowered into sump at the Daly West mine, Park City, Utah.

October 19, the new Langdon shaft of the Wharton Steel Co. at Hibernia, N. J., was flooded and 12 men were drowned.

October 22, fire damaged the Kingdon shaft of the Old Dominion Co. at Globe, Ariz.

1912.

January 16, two men were killed by falling timber in the Kingdon shaft of the Old Dominion Co.

May 6, three men were killed by fall of roof in the Dinger mine near Webb City, Mo.

May 13, a cave-in at the Norrie mine of the Oliver Iron Mining Co., Ironwood, Mich., killed seven men.

May 18, three men were suffocated by gas from a gas engine in the Williams-Luhman mine, Shoshone, Wyo.

July 7, a dynamite explosion killed 10 men and injured 2 others when loading holes in the Eureka pit of the Nevada Consolidated, Ely, Nev.

July 7, in the Braden copper mine, Chile, at least 36 men were killed by an explosion underground.

August 10, three men were drowned and one asphyxiated in the Hird shaft of the Frontier mine at Benton, Wis. The shaft was being bailed out, and the men were overcome by foul air, three falling into the water.

August 12, two men were killed by a dynamite explosion on the twelfth level of the Gold Sovereign mine, Cripple Creek, Colo.; the cause of the explosion is unknown.

September 6, one man was killed and five others slightly injured in an overwinding accident at the Bunker Hill & Sullivan mine, Kellogg, Idaho.

October 7, a fire occurred in the Bunker Hill & Sullivan mine; only one life was lost.

October 12, a fire in the North Lyell mine, Tasmania, imprisoned 90 men and caused the death of 42.

October 17, four men were killed by a falling crosshead at the Cleveland-Cliffs' North Lake mine, Ishpeming, Mich.

1913.

January 3, three men were killed in the Imperial mine near Joplin, Mo., by failure of the hoisting engine at blasting time.

January 7, a fall of back in the Old Jordan mine, Bingham, Utah, killed three men.

January 25, one man was killed and three others injured in the Pittsmont mine, Butte, Mont., due to confusion of a hoisting engineer at blasting time.

April 17, a cave in the Miami mine, Ariz., killed 5 men and injured 16.

April 23, a hoisting accident at the Leonard mine, Butte, Mont., killed five men and injured nine.

May 3, two men were killed by a fall of ground in the Liberty Bell mine, Telluride, Colo.

May 8, two men were killed by a fall of rock in the Idaho-Maryland mine, Grass Valley, Cal.

June 6, two men were killed by a cave-in at the Morris mine of the Giroux Co., Ely, Nev.

July 17, reported that 40 men were killed in a fire at a sulphur mine near Castel Termini, Sicily.

July 27, two men were killed in the wreck of the hoisting engine at Green Hill mine, Mace, Idaho.

August 13, nine men were killed by the breaking of the drawbar of a car on Coronado incline of the Arizona Copper Co., Clifton, Ariz.

August 21, 42 miners were killed by the dropping of the cage in the Edgar shaft of the Mysore mine, India.

November 17, an explosion of dynamite in the Kennedy mine, Jackson, Cal., killed three men and injured one.

CHAPTER XI.

SOME UNUSUAL AND HISTORIC ACCIDENTS.

By W. R. INGALLS and L. O. KELLOGG.

Certain of the accidents listed in the chronology of Chapter X are of more than ordinary interest and some of these have been selected for description in more detail. In making this selection it has been attempted, so far as possible, to illustrate the more serious dangers to which the miner is subjected and which the provisions of the accompanying code are designed to combat. At the same time the selection has been confined to such accidents as have assumed importance in some way or other, either because of the large loss of life involved or threatened or because of unusual attending features. Fires, caves of ground, explosions, hoisting accidents, and floods are described. The accounts are taken in some cases from authoritative articles in the technical press and from authoritative information specially obtained in others. In some cases the sources of the information have been given, in others they have been withheld, usually at the request of the informants.

There is possibly some danger that the accidents selected for description may give a false idea of the hazards existing. The more spectacular accidents and those causing wholesale death are not those most important in the aggregate, as they are relatively infrequent. This is true of mine fires, the accounts of many of which will be found included herewith. There will be found also accounts of accidents which are highly unusual; these are instructive chiefly as showing the great variety of dangers against which the miner must take precaution.

MINE FIRES.

LONDON MINE, NOVEMBER 29, 1909.

Mention has been made elsewhere of the fire at the London mine of the Tennessee Copper Co., where the existence of two openings to the surface prevented loss of life, although the fire itself was of a nature capable of proving disastrous. The account following is taken from one written by N. H. Emmons,^a at that time general manager of the company.

^a Emmons, N. H., Fire in London mine of Tennessee Copper Co.: Eng. & Min. Jour., December 11, 1909, pp. 1181-1182.

The mine ore bins caught on fire at about 3.30 p. m., November 29, 1909, from sparks thrown by a locomotive. The building being constructed entirely of wood and being very dry the fire spread rapidly and water could make no impression on it; the flames rushed to the top of the breaker house, about 120 feet high, and consumed the entire building in a short time. The crusher fell from a height of about 75 feet, demolishing the engine that was directly below it.

The shaft dips 74° and the timbers falling from the crusher house set the shaft timbering on fire and gave notice to the men below who, however, had also been notified through a speaking tube that the breaker was on fire. There were 54 men in the mine, 12 of them being on the fifth level. All of these 12 men climbed up to the fourth level and four of them to the third, the other eight taking refuge in a drift so as not to be overcome by the smoke from the falling timbers. Forty-six men were taken out through an open cut which had been a ladderway, but from which the ladders had been removed on account of blasting. Ladders were put in again and the men taken to the surface without having experienced any ill effects from the smoke. Of these 46 men the four from the fifth level claimed to have called to their eight companions to follow them and thought they were doing so, but these eight must have become panic-stricken, since they did not follow above the fourth level.

The smoke soon filled the upper levels, except at the open cut, to such an extent that no one could go down for the imprisoned men, and work was started on the first level putting in a brattice at the crosscut to the shaft, the shaft being about 100 feet in the footwall at the first level and 300 feet at the fifth level. As soon as the brattice was put in this level cleared rapidly, and the fresh air blowing down from the winzes to the second level cleared this up, but more slowly. It was found impossible to put a brattice on the second level on account of the heat and smoke. A compressed-air line was brought in from the Burra Burra mine, about a mile away, to the open cut at the London mine, using partly a water line and partly an air line already in. Fire hose was attached to this line and taken down from level to level. It was found necessary to reduce the pressure from 90 pounds to 50 pounds at the compressor in order not to blow off the connection to the hose. The hose was carried from level to level and men lowered through winzes with ropes as soon as they could stand the heat and smoke.

The United States Geological Survey sent an equipment of oxygen helmets from the Knoxville station and an instructor, but by the time they arrived the air was clearing so that they were unnecessary and, the men being afraid of them, they were not used, although tried. Three men were lowered to the fourth level about 10 p. m. on November 30 and reached the imprisoned men at 11.30. They found them in a small stope, where there was running water from a diamond-drill hole, the men having barricaded the drift to the stope to keep the fumes out. The men were all in good condition but weak from lack of food and air, soon recovering, however, when they were brought to the surface and cared for.

No better example could be instanced of the necessity of the two-outlet precaution. Although it is impossible to say what would have been the outcome if the second outlet through the open cut had not been available, it is certain that there would have been loss of life, probably heavy loss, but as it was every man was saved. This case also illustrates the advisability of having fire-doors in the main drifts leading from a shaft, a requirement which the committee has inserted in its code, but only to a limited extent in view of its novelty in present mining practice.

GIROUX SHAFT, AUGUST 23, 1911.

A fire in the Giroux shaft, of the Giroux Consolidated Mines Co., at Ely, Nev., on August 23, 1911, was disastrous in the loss of life which it caused and unusual in that these seven deaths occurred at widely separated points and at considerable intervals. As is usually the case, the cause of the fire remains unknown. It was at first thought that a dynamite explosion set fire to the timbering, but the fire originated in the station of the 1,000-foot level where no work was supposed to be going on and it is now believed that two men, who in passing from the 770-foot level to the 1,400-foot level had stopped at the 1,000-foot level, must have left there a lighted candle snuff, the flame from which caught the timbering. The greatest damage occurred at the 1,000-foot level where the station and most of the ore pocket were destroyed. It extended, however, to the 770-foot level and the 1,200-foot. The mine was flooded and the water was not finally removed until February, 1912, more than six months later.

Of the deaths, one was that of the cage tender who attempted to come up the shaft on the cage and fell off 15 feet below the collar. Out of a cage load of men hoisted from the 1,400-foot level one was pulled off the cage, presumably by a manila bell cord. This had probably been burned where the fire was hottest and broke when pulled for the hoisting signal, so that it fell down the shaft and entangled the man who was killed. Two men were killed by inhaling gas or flame as they were being pulled through on the cage. Finally three men attempted to climb out on the ladders of the other shaft, the Alpha, and were overcome by gas. It is held that the turning on of the sprinkling system may have reversed the air currents and thus driven the products of combustion out through the Alpha shaft. Three more men were burned but recovered.

Fire doors might have proved a means of safety in this case also; although the reversal of the air current was not proved, it is possible that the sprinkling water may have acted in that way. This danger was discussed in Chapter V.

BELMONT MINE, FEBRUARY 23, 1911.

In a fire at the Belmont mine of the Tonopah Belmont Development Co. in Tonopah, Nev., on February 23, 1911, 17 men lost their lives. The fire was not a serious one; little damage to the mine resulted. It was discovered while still small and was attacked for some time at close quarters, yet the unfamiliarity of the men with fire-fighting methods, coupled with a reversal of the air currents, permitted an insignificant blaze to develop into an appalling disaster, a striking example of the insidious nature of the underground fire.

The Belmont mine had two shafts, the Belmont, normally upcast, and the Desert Queen, normally downcast. Smoke was first noted by the eager about 5.50 a. m. An hour or two of searching was required before the fire was discovered at the bottom of a winze on an intermediate level which did not open into either shaft, communication being had by means of the winze in question and two raises to the levels above. The fire was burning in some mine timber which had been piled at the winze bottom for distribution in the stopes. It seems reasonably sure that the fire was caused by a lighted candle or a snuff left in the timber by a man of the night shift, which quit work at 3.30 a. m. It was decided to build a brattice in the drift and close the winze above the fire. Up to this time there was dense smoke in but few parts of the mine, and although the smoke issuing from the Belmont shaft prevented the descent of the men, a good many of them, including the timbermen, went under through the Desert Queen shaft. When the fire was discovered men were detailed to call out of the mine everyone except those fighting the fire. The men were scattered, however, and did not obey orders promptly, so at the time the disaster occurred there were a good many men underground in different parts of the mine. It is uncertain just what happened but apparently some reversal of the air currents threw the smoke into parts of the mine that had previously been safe. The men who died were trapped at different points, several in the shaft stations whither they had crawled but from which they were unable to signal. According to one report four men were overcome and fell off the cage while being hoisted. The fire was put out that same night by an organized party and the bodies of the men recovered the next morning. The mine, as was usual at that time, was not equipped with rescue apparatus and fire extinguishers were not at hand, nor was satisfactory rescue apparatus to be had off-hand in Tonopah. The drastic lesson of the disaster, however, was taken to heart. Tonopah is now well equipped with mine-rescue apparatus, fire drills are practiced, and fire patrols maintained.

This disastrous accident again points to the desirability of fire doors in the main drifts leading from the shaft stations. It points also to the desirability of a general danger signal, such as the flashing of the electric lights, peremptorily commanding all men to leave the mine.

NORTH LYELL MINE, OCTOBER 12, 1912.

The most disastrous metal-mine accident of recent years occurred at the North Lyell mine in Tasmania on October 12, 1912, the result of an underground fire. The mine was opened by an adit level and a main shaft. The shaft crossed the adit level at the 300-foot point

of the former. From a point farther in another shaft, the "engine winze," made a second communication between the adit and the mine workings. The main shaft had its hoisting works on the surface. A winch on the adit level served the engine winze for a few hundred feet down to a point where moving ground had blocked the winze. Another winch on the 700-foot level served the lower levels of the winze. The company was opening the blockade in the winze at the time of the fire.

The fire started in or near the 700-foot pump station. As has been the case time and again, the first manifestations were not treated as very serious. However, the men were hurried out of the mine from the accessible levels as rapidly as possible and rescue parties were organized. Hoisting was continued in the main shaft until the cage stuck. About 70 men got out early in this way, leaving 90 or 100 still in the mine. The main shaft, of course, became an upcast and efforts were made to open the block in the engine winze. It was opened at last and became a strong downcast, a large quantity of falling water aiding in creating this condition. The smoke was gradually driven back to the main shaft on the various levels, working from the engine winze, by the use of compressed air and brattices. Finally communication was established across the 1,000-foot level and the 50 men who had taken refuge there on the other side of the main shaft were rescued. Their presence and their situation had been established previously by means of a cord dropped down the main shaft and by the same means supplies had been conveyed to them. They had compressed-air lines accessible which furnished the air to breathe.

Investigations of other workings where it was thought that men might be still alive resulted in finding only dead bodies. It was concluded that the faint chance of some men being still alive would not justify the risk incurred by the rescuers and that further search would best be deferred until the fire was extinguished. It was thought that it had nearly burned itself out. Attempts were made to seal the mine but without success and when it was found that the fire, far from being nearly burned out, had spread and increased in intensity, the mine was flooded. When the workings were afterwards pumped out and all the bodies recovered, the number of dead was found to be 42 all told.

The accident was the subject of a searching investigation by a Royal commission, which, however, failed to establish the cause of the fire. This was at first attributed to the electrical apparatus. A suggestion of incendiarism was later put forth. The commission was inclined to reject these causes and to attribute the fire to some candle left in a dangerous position. It was brought out that another outlet to the adit level existed through the upper stopes, but the men

did not seem to know of its existence or else did not know the way. Furthermore this outlet was one not easy to travel. It was found that the eddy currents set up would carry the smoke into what would have been considered safe workings. The use of helmets and of diving apparatus in fighting the fire was not successful. Many if not most of the deaths seemed to be the result of carbon monoxide poisoning.^a

The lessons of the disaster are numerous. A trained fire brigade could have done much. Mine-rescue equipment should be maintained and the men taught its use as provided herein. On the suspicion of danger, all men should be called out of the mine at once. For this purpose a general-alarm signal is prescribed in this code. The existence of a second outlet is of no value unless it is known to the men and is plainly marked. For this purpose the code prescribes signboards. But, as stated several times elsewhere, the best provision against a fatal outcome to a mine fire is to prevent the occurrence of the fire.

HIGH ORE-MODOC MINE, JANUARY 14, 1911.

The High Ore-Modoc mine of the Anaconda company at Butte, Mont., is connected on the 2,200-foot level with the Diamond mine of the same company and on the 1,200-foot level with the Ballaklava shaft. On Saturday evening, January 14, 1911, as the night shift was being lowered, smoke and gas from a fire were detected. Work of getting out the men was at once begun. A number of men, mostly on contracts and on the pumps, were working on a shift that had gone on at 3 p. m. Messengers were sent to the working places at once to notify this shift to vacate the mine. One of the contract men, Michael Belangie, who had got out safely returned with the station tenders to notify some of the pumpmen. He and these pumpmen remained too long exposed to the fumes of the fire and were overcome. When brought to the surface they were revived with difficulty, with the exception of Belangie, who died. The foreman of the Diamond mine adjoining sent two of his men with a shift boss to seal a door on the 2,200-foot level that had been provided for just such an emergency. When they failed to report after a reasonable interval, the foreman investigated and found that they had closed the door, but had then been overcome, and were lying nearby. The shift boss could not be brought to, but the other two men recovered. There were thus two fatalities.

The fire started a short distance west of the neighboring Ballaklava shaft. The cause is unknown, but the deadly candle snuff is suspected. The part of the mine on fire was bulkheaded off, exhaust fans established, and the fire extinguished after a few weeks.

^a Account compiled from several published articles in Australian and British papers.

HARTFORD MINE, MAY 5, 1911.

A fire at the Hartford mine on the Marquette iron range of Michigan on the morning of May 5, 1911, illustrates the extreme difficulty of guarding against casualties from this source. The fire was discovered in the No. 2 shaft of the mine by the electrician and pumpman, who saw a burning brand drop down the shaft. They found that the ladder and pipe compartments were burning and at once notified the superintendent, at the same time taking steps to put out the fire. Beside the No. 2 shaft, the mine had a No. 1 shaft connected on the second level with the No. 2 and from the bottom, or fifth level, at the 975-foot point, it was connected with a neighboring mine, the Cambria. The fire apparently started near the pocket of the 750-foot level, the third. With two openings to the surface beside the burning shaft, there seemed small likelihood of any loss of life occurring. As a matter of fact, seven men were suffocated in various parts of the mine. One man attempted to fight the fire and was overcome near where it occurred. Another tried to build a bulkhead shutting off an underground opening at the Cambria and was also overcome; he had been previously ordered from the place. A third jumped off a cage just as it was to go up, thinking of somebody that had not been notified or of something that he had forgotten. Two men working on the second level tried to reach the bottom level and were killed; they had passed by a door leading to No. 1 shaft on their way. Also two men in a raise above the second level some distance from the shaft were unable to make their way to safety. It is evident that at least five of these men could have been saved but for their own mistakes. Three of them, it would appear, were influenced by a sense of responsibility toward others and took large risks.

It must be admitted that disasters of this sort are exceedingly difficult to guard against. Apparently there must have been a reversal of the air current. The most available means of air control are fire doors and a fan. There are little data as to what can be done along this line, however. The best precaution against a fatal outcome to a mine fire is to prevent the fire starting. The origin in this case is unknown; of the three possible causes, namely, electric wires, a candle snuff, or incendiarism, the candle snuff seems most probable.

The damage to the mine was slight but there was some difficulty in recovering the bodies, since there were no helmets available. All the companies in the district have since supplied themselves with mine-rescue apparatus.

EXPLOSIVES ACCIDENTS.

ALASKA-MEXICAN MINE, MARCH 2, 1910.

The most disastrous explosive accident in recent years was that occurring in the spring of 1910 at the Treadwell group of mines on Douglas Island, Alaska, 37 men being killed and 9 injured. The following description is substantially that of the general superintendent, R. A. Kinzie.^a

At 11:30 p. m., March 2, 1910, the powder magazine on the 1,100-foot level of the Mexican mine exploded, killing 37 men and injuring 9. Sufficient powder for the night and day shifts was delivered to the underground magazines every 24 hours. The 1,100-foot magazine furnished powder for that level only, and the quantity delivered there was 20 to 30 boxes. The magazine was a chamber cut in the rock and boarded up in front; it was situated 25 to 50 feet from the shaft and separated from it by a pillar. A partition divided the magazine into two rooms, each having a door. The doors had open gratings, through which the interior of the magazine could be seen; they were always kept locked, except when the stope boss at certain times passed out the powder to the miners. Light was furnished by a 16-candlepower lamp a short distance inside the door. There was no wiring over the stored powder. No heat was brought in, the powder being thawed before delivery.

The explosion occurred just as the night shift was waiting to go to the surface to eat. The men on the 990-foot station reported two explosions. The first put out their candles, but was of no great violence. As they lighted up again before proceeding to another shaft, a second explosion of greater violence knocked them over, seriously injuring one and slightly injuring three. The men loading the skips, only 45 feet below the 1,100-foot level, were uninjured, as were those on the 1,200-foot and 1,300-foot stations. The posts of the 1,100-foot station were knocked out, and with the lagging and other timber formed a mass of débris which closed the shaft. From the débris 22 bodies were recovered; 5 injured men were also taken up. The doors across the skip compartments were closed, as ore was being hoisted from the level; one body was found on these doors. The man-cage compartment was open and eight bodies were recovered from below in this compartment. The light board shed used for a stable was entirely demolished; two bodies were found there; one of the two horses was killed, the other uninjured. This stable was about 100 feet from the shaft down the main drift. Two bodies were found along the drift, and the fragments of at least one body were found in a corner of the magazine itself. As is usually the case with an explosives accident, the cause could not be determined. As is frequently also the case, no great damage was done to the mine. A rescue party reached the scene within 35 minutes after the explosion, and the cage was running in about 11 hours. The position of the magazine near the shaft but beyond it, considered in reference to the main drift, precluded the possibility of any man being cut off from escape in case of accident and also aided in the rapid dissipation of the gas; no man was overcome in that manner.

DIAMOND SHAFT, MARCH 3, 1909.

A blasting accident which occurred in the bottom of the Diamond shaft in Butte, Mont., on March 3, 1909, was unusual, in that although one of the men who were in the shaft bottom at the time of the explosion survived the accident, yet his testimony left the true cause still undetermined. Five men, part of a crew that had the contract for sinking the shaft, finished a round and attempted to blast it.

^a Kinzie, R. A., Explosion at the Alaska Mexican mine: Eng. and Min. Jour. Mar. 19, 1910, p. 603.

Four of them were caught by the explosion and killed, the fifth, who was at the cage, was pulled up badly wounded. His story of what happened is practically all that is known about the accident. The men had 25 fuses to "spit" or light. The survivor, with another man, took one side of the shaft and the remaining three men the other. The two men finished "spitting" their fuses and started to help the others. When only two fuses remained unlighted, the survivor was sent to the cage by the boss. He had just touched the cage when a blast went off. He shouted to the men to come to the cage, but without result. On the second blast he signaled to be hoisted. Two explanations are possible—that the men utterly misjudged the time they had consumed in "spitting," or that a defective fuse caused a premature blast. The men were all experienced and skillful miners. The fuses were 8 feet long. The number of men and the routine was that followed throughout the job in question and always with success, except in this case.

KEATING MINE, JANUARY 18, 1911.

A dynamite explosion at the Keating gold mine near Radersburg, Mont., on January 18, 1911, killed six men, at least three of them by asphyxiation. Although the exact cause of the explosion is, as usual, unknown, the evidence points strongly to the accidental detonation of some powder on a shaft station by some falling object. During the morning the skip had been derailed, and, as a result, five men were working in the inclined shaft about 2 p. m., repairing rollers. There was probably 200 pounds of dynamite in the powder thawer and 900 pounds of frozen dynamite on the 200 station. The thawer was about 80 feet from the 200 station; it consisted of some shelves in a rock niche, with electric lamps for heating. It is known that the "powder monkey" visited the thawer just before the explosion. Two explosions were reported at first. Later this seems to have become a matter of doubt.

At all events, the men repairing the shaft were all thrown down by the shock; two of them fell in the skip, which had been held nearby. Falling timbers caught the bell rope and gave the hoisting signal; the men were drawn to the surface unconscious, but they survived. The other three men in the shaft probably died from inhaling the fumes after being knocked helpless. The "powder monkey" was preparing primers at his bench on the 300 level, and two men were at work in the face on that level, 750 feet from the shaft. In their attempt to escape these men were caught by descending gases and killed. If they had remained where they were or had descended through upcast stopes to the lower levels, they would have escaped, as did the other men in the mine. The station and shaft in the vicinity were badly wrecked; much of the frozen dynamite was found scattered about. It was at first supposed that the thawer had exploded and detonated

the dynamite on the station, but afterwards the effects of a strong explosion were found lacking in the immediate vicinity of the thawer, and the most likely hypothesis is that one of the men in the shaft had dropped a tool or other object which struck and detonated the station dynamite.

Too great care can not be exercised in the handling of dynamite. It should be left exposed only for such time as is absolutely necessary, and never in shaft stations if possible to avoid it. The handling of powder as described in this case would be quite contrary to the rules of the committee's code.

COPPER FLAT MINE, JULY 7, 1912.

While loading a surface drill hole of the Nevada Consolidated Copper Co., July 7, 1912, 10 men were killed by a premature explosion. The accident illustrates the necessity of care in handling explosives on the surface as well as underground. The causes of the explosion are quite undetermined, all evidence having been obliterated by the explosion itself. The facts so far as known seem to be as follows: A group of men were engaged in charging the hole, which was in the capping on what was called the Berry High Line level. Holes of this type hold a relatively large quantity of powder, and are usually loaded by five or six men, who drop the powder in. In this case Trojan powder had been first charged and there remained, it is believed, five boxes of Hercules Special, an explosive containing, according to report, 20 per cent of nitroglycerin and 20 per cent of ammonium nitrate. Two boxes of this were left unexploded. The reason for believing that three boxes exploded is that three holes were blown out in the ground; but it might have happened that boxes were piled one on another, in which case each hole would represent more than one box. What actually exploded the powder remains unknown.

IMPERIAL MINE, JANUARY 3, 1913.

An accident preventable by proper precaution occurred at the Imperial mine in the Joplin district of Missouri due to the failure of a hoisting engine. A new shaft there had just reached the ore horizon, and drifting had begun, with the face still only a few feet from the shaft. On January 3, 1913, three men had prepared a round of 50 to 60 shots, lighted the fuses and signaled to be hoisted. The engine refused to work, there was no other exit, and the three helpless men were effectually trapped. They were buried under tons of rock and killed. It was reported that the compressed air with which the hoist was driven was frozen, since the hoist had been little used for some time before and the day was extremely cold. It was also reported, however, that an essential part on the hoist had broken.^a

^a The account of this accident was obtained from a reliable, but unofficial, source.

No better example could be instanced of the necessity for two of the provisions in the accompanying code, namely, that every shaft in process of sinking be provided with a ladderway from top to extreme bottom, and that whenever blasting is to be done in a shaft bottom, a preliminary signal be given and the hoist tested to see that it is in working order. If the report of the accident as given is correct, the observance of either of these two precautions would have averted the loss of life. The \$12,000 or so which the death of these three men would have cost the operator in a State with a typical workmen's compensation law, would have paid for many thousands of feet of ladderway. No particular blame attaches to the operator of this one mine. He was merely following the characteristic practice of the district where the providing of ladderways is deplorably rare.

HOISTING ACCIDENTS.

RICHARD MINE, JUNE 7, 1910.

At the Richard mine of the Thomas Iron Co., in New Jersey, five men were killed in a hoisting accident on June 7, 1910. The No. 6 slope or shaft of this mine is carried down on the deposit at an average dip of about 52°. Men were hoisted through this shaft by means of the ore car or skip and were required to ride in the bottom of the conveyance. The five men in question, instead of obeying this rule were riding in the bail. At a point about 100 feet below the surface, the angle of the shaft changes sharply, and in passing this point the weight of the five men on the bail upset the conveyance, all five being spilled down the shaft and killed.

Riding on the bail is of course dangerous always; and in this case was contrary to the company's own rule. The practice of riding on the bail of skips is discussed in Chapter V.

BUTTE SUPERIOR MINE, SEPTEMBER 3, 1911.

A double disobedience of rules cost six men their lives at the Butte Superior mine on September 3, 1911. It was the custom at this mine for the station tender to collect the dull drill steel on the various levels about 15 minutes before the end of the shift and have it hoisted through the vertical shaft to the surface in what was called the "drill boat." Only the station tenders were allowed to ride with this steel, and in fact no other men were supposed to be at the shaft station at the time it was hoisted.

On the night when the accident happened, Saturday night, some of the men were anxious to get out early and start the double holiday of Sunday and Labor Day. They took the chance, therefore, of quitting a little before the end of the shift and coming out to the station to ride up with the steel. The cage started at the 1,300 level where drill steel was loaded, and one of the men in question got on there. At the 1,200 level station also two men got on, and two others

at the 900 level. When the cage left the 900 level it contained about 250 pieces of steel in the drill boat and six men, including the cage tender, being so crowded that the station tender who stayed behind had trouble in closing the cage gate.

It is not known exactly what happened; either the drill steel got disarranged, or more probably, one of the men got caught by a wall plate of the shaft timbering; at all events both steel and men were dragged from the upper deck of the cage where they were riding. The hoisting engineer felt a slight tremor in the rope and stopped the hoist, which was running slowly because of hoisting steel. One of the men was found on the lower deck of the cage, the other five in the shaft sump. The five men, who had no business on the cage, were all young and inexperienced underground. Although the cage tender was only an accessory to the infraction of rules, he paid the same penalty as the others. The inquest brought out the fact that the station tenders were afraid to refuse permission to ride lest they be attacked later outside the mine by those refused.

This code strictly prohibits riding with drill steel on the part of the miners in general. The need of the prohibition is plainly evidenced here.

LEONARD MINE, APRIL 23, 1913.

A failure of the braking apparatus on the hoist at the Leonard mine in Butte resulted in an accident which is perhaps more noteworthy for the number of men who escaped death than for the number of those killed. According to the account published in the *Engineering and Mining Journal*,^a the day shift was being lowered on the morning of April 23, 1913, when the engineer lost control of the hoist and both cages dropped to a shaft bulkhead at the 2,200-foot level. Hoisting and lowering usually were conducted in balance; in fact there was a rule of the company that men at least should not be lowered under the brake alone. At the time of the accident, however, the engineer had four men on the east cage who were going to the 60-foot level. The west cage was standing at the 1,400-foot level. The engineer started to lower the east cage under the brake alone, without moving the west cage. It is supposed that the rod connecting the brake with the lever broke after the brake was released, leaving no effectual means of controlling the east-rope reel. That cage dropped with nothing to stop it other than friction in the shaft. The four men on it were instantly killed. The great speed attained by the reel burst it and wrecked the hoist room. A fifth man was killed near the shaft by the flying metal.

The controlling mechanism of the west reel was also wrecked and the west cage allowed to drop. Four men had stepped off this cage at the 1,400-foot level; there remained three men on the lower deck

^a Editorial, Two hoisting accidents and their lesson: *Eng. and Min. Jour.*, vol. 95, May 31, 1913.

and ten on the upper. The signal had just been given to hoist to the 1,300-foot level, when the east cage went by as it fell. Two men from the lower deck of the west cage leaped to the station before the cage began to fall; the other eight were carried with the cage the full 800 feet of drop and, remarkably enough, none of them was killed although all were more or less seriously injured. It is supposed that the east cage in falling had sprung the dividing timbers over so that the west compartment of the shaft was squeezed together a little. It is probable also that the safety catches were released enough to have a considerable braking effect, although the drag of the rope and the resistance of the revolving reel prevented them from coming fully into action.

BUNKER HILL & SULLIVAN MINE, SEPTEMBER 6, 1912.

An overwinding accident, although not a typical one, occurred at the Bunker Hill & Sullivan mine in the Coeur d'Alenes, September 6, 1912. The men were hoisted into a surface bin and since the shaft was inclined they were not precipitated down the shaft. The men were five shovelers from the bottom level of the mine and were being brought to the surface in the self-dumping waste skip. Instead of stopping at the shaft collar, the engineer pulled the skip and its load into the rock bin. At the inquest, the engineer testified that the sprocket chain driving the engine indicator had slipped off and the indicator therefore failed to show the approach of the skip to the surface. There was reason for doubting his evidence, and it seems more likely that he merely forgot the signal, which had been given correctly, and thought he had no men on the skip. One man was killed by having his head crushed, the others were not injured seriously.

There have indeed been overwinding accidents ascribable to derangement of the engine indicator. For this reason among others the code of the committee prescribes a mark on the rope as well as an indicator on the engine; and, furthermore, prescribes a diminution of speed as the cage approaches the surface.

NORTH LAKE MINE, OCTOBER 17, 1912.

A falling bucket crosshead caused the death of four men at the No. 1 shaft of the Cleveland-Cliffs North Lake mine on the Marquette range, October 17, 1912. The shaft was in process of sinking. At about 6 o'clock, the upper pump in the shaft stopped and, the regular pump man not being out, orders were given for a miner to act in his stead. One of the miners accordingly came to the surface, got a can of oil and was lowered again to the pump station, 197 feet above the shaft bottom at the time. About five minutes after getting off he signaled the engineer to lower the bucket to the bottom.

The miners there decided to come to the surface and eat their lunches while waiting for the pumps to lower the water in the shaft. The crew of five got on the rim of the bucket and signaled to hoist. When they arrived at the point in the shaft where the crosshead should have caught normally, they found that it was not there and one of the men called out for them to hold tight. Then the crosshead fell and knocked the men from the bucket, four of them fell to the bottom, and the fifth, the one who had called the warning, happened to fall on a divider of the shaft timbering and was saved.

The crosshead was broken and no investigation as to its condition was possible. However, everyone questioned stated that it had appeared to be in good condition previous to the accident; the runners, furthermore, were found to be unusually smooth. Eight feet above the pump station there was a joint in the guides and just below this the space between guides was a scant 5 feet; the width of the crosshead itself was 4 feet 11½ inches. This point in the shaft was that where the crosshead would have stopped to let a man off for the pump station. The stay of five minutes at the station would have been time enough to allow the vibrating rope to come to rest, giving the crosshead a better chance to stick.

The question of the advantages and hazards of using an ordinary crosshead such as this was, have been discussed elsewhere in this report. Undoubtedly the best practice calls for a safety crosshead, one that can not possibly be held up except at a predetermined point. This crosshead, however, was 3 feet 5 inches high, as compared with its width of approximately 5 feet, and these dimensions should insure reasonable safety.

FALLS OF GROUND.

NORMAN MINE, MARCH 11, 1911.

Probably the worst disaster connected with open-pit work in this country was that at the Norman mine on the Mesabi range of Minnesota. This large property was being worked by the Oliver Iron Mining Co. with steam shovels in the usual manner. On March 11, 1911, as reported by W. H. Harvey, the county mine inspector, a number of men were engaged in raising and lining up the track in the approach to the pit when a great quantity of ore from the north side let go and slid down so suddenly that the men had no time to escape, and 14 were caught and killed. The pit at the place where the accident occurred was 358 feet wide from crest to crest of the ore body and 51 feet wide at the bottom; its depth was 205 feet. The bank thus had some slope, but the dip of the ore was toward the south, giving better opportunity for sliding. It is assumed that the bank had been loosened by alternate thawing and freezing. It appears that the men had no idea that the place was dangerous, as it was used as a place of refuge when blasting was being done.

No example could more forcibly illustrate the difficulty of dealing with the one greatest source of accidents, namely, falls of ground. Here, in broad daylight, in plain view of everybody, the most critical conditions remained quite unsuspected by those in the best position to observe them. How much greater must be the difficulty in a dim light underground, and especially in chambers where the back is far above the observer.

BUFFALO-SUSQUEHANNA MINE, AUGUST 19, 1911.

The open pit of the Buffalo-Susquehanna mine at Hibbing on the Mesabi iron range in Minnesota was the scene of a run of bank which killed 3 men and injured 21 others, 5 of these only slightly, however. Stripping of the overburden was being carried on in the pit by the Winston-Dear contracting company for the Rogers-Brown Ore Co.

A slope of $\frac{3}{4}$ to 1 was designated by the engineers and was being maintained. While the night shift was at work on August 19, 1911, the bucket of one of the steam shovels was buried by a small fall of earth and sand. Three men were detailed to dig this away. The shovel was digging in relatively hard material, but this was overlain by softer ground. While working these men were caught by another rush of sand, and then a much heavier fall from the high bank almost covered the shovel. The men killed were those caught under the shovel or against its side. Others were swept aside and escaped with little or no injury.

It is probable that the darkness was the cause of the accident's resulting so seriously. The first small slide was no unusual thing, and it was impossible to see at night the dangerous conditions in the bank overhead. The darkness also, together with the disablement of the shovel, which included the extinguishing of the lights and the breaking of the steam pipe, made the work of rescue much more difficult and dangerous.

GOLDFIELD CONSOLIDATED MINE, SEPTEMBER 25, 1909.

On Sept. 25, 1909, a stope of the Goldfield Consolidated Mines Co., of Goldfield, Nev., caved, and the caving extended to the surface, wrecking part of a stamp mill and killing three miners underground. The Hampton stope of the Combination mine was opened on an extremely high-grade ore body, and was mined for about eight months. The stope was about 70 feet wide, heavily timbered with square sets, and filled with waste. Nevertheless the hanging wall came in with the results indicated. The 20-stamp mill had to be abandoned.

The practice of stoping near the surface is impossible of control by general regulations; every case must be judged on its merits. The question is further discussed in Chapter V.

MIAMI MINE, APRIL 17, 1914.

The Miami copper mine at Miami, Ariz., was the scene of a most unusual accident on April 17, 1914. The combination method of mining in use there involves caving the capping. The capping over what is known as the northwest ore body, which was about ready for caving, had given warning on April 16 that a collapse was imminent by the increased amount of cracking and slabbing off of ground. For this reason the men were kept out of that part of the mine which the caving was expected to affect. When the fall did come the next day an enormous compression was set up through the mine workings. It is estimated that 3,500,000 cubic feet of air was displaced. The rush of air was irresistible. Men and equipment were thrown about, and in the open workings, where the rush of air was greatest, the effect was especially disastrous. Five men altogether were killed and 16 were injured. Nobody was caught by the cave itself. The cost to the company was enormous also, the system of mining being quite disorganized for the time being in that part of the property.

NORRIE MINE, MAY 13, 1912.

On May 13, 1912, seven men were killed by caving ground at the Norrie mine of the Oliver Iron Mining Co. on the Gogebic range in Michigan. A party of ten miners and three trammers on the night shift were working home from the boundary of the property above the twentieth level of the mine. Hearing ground dropping they retired to what they thought was a safe place, the main drift, which was securely timbered and had 35 to 40 feet of solid ore above it. The cave, however, did not come at the place where they had been working, but instead in the very place of refuge to which they had retreated, crushing in the drift timbers over a length of about 80 feet. Six men were rescued alive after about 24 hours' work, but one of these died about a week later in the hospital.^a

M. & B. MINE, APRIL 22, 1909.

A cave-in at the property of the M. & B. Mining Co. near Duenweg, Mo., on April 22, 1909, caught and killed three men; two were killed outright, and the third, the superintendent of the property, died soon after being rescued from under the fallen timber. Drifting was being carried on alongside some old caved ground and into soft ground. The end of the drift was heavily timbered, but for some time had given evidence of taking excessive weight. Some distance back, a section of the large drift from the shaft had been run without timbering, but was later timbered in order to protect those passing against falling pieces of rock. This timbering was not intended to

^a Data obtained from a source outside the company organization, but believed to be reliable.

support the ground and was not blocked securely against the back. On the day of the accident a cap in the soft ground was found to be cracking and it was decided to place a false post under it. This was cut and brought down after the noon hour. By that time the cap had settled still another 6 inches and it was found necessary to cut the post off. Some of the men were sawing the post and others were standing some distance back toward the shaft when the cave came. The three men killed were caught by the falling timbers when they were running toward the shaft. The unblocked timbers mentioned were unable to withstand the rush of the caved ground.^a

Falls of ground are admittedly the source of underground accident most difficult to provide against. In this instance, however, the result seems attributable to a clear violation of good practice in neglecting to block the timbering securely and to a failure to heed the unmistakable warnings of what was coming.

DINGER MINE, MAY 6, 1912.

A fall of roof occurred at the Dinger mine in the Joplin district on May 6, 1912, which killed three men. The rock that fell was a slab about 2 feet thick which gave no sign of looseness when tapped and sounded by the roof men and was apparently safe. After the fall, however, it was found that a thin sheet of mud separated it from the rock above and constituted a plane of weakness. The difficulty of dealing with cases of this sort is obvious.

ALPHA SHAFT, DECEMBER 4, 1907.

The Alpha shaft of the Giroux Consolidated Mines at Ely, Nev., caved on the morning of December 4, 1907. Of the five men caught below the cave, two were killed instantly and three were imprisoned. The rescue of these men after 46 days is one of the most dramatic incidents in mining history. The account here given is taken from one by E. W. Walter,^b the manager of the company.

The shaft for about 500 feet was in good ground. Below the 500-foot point the formation was much less stable and between the 580 and 600 foot points the rock was crushed to a powder by faulting. Below 600 feet the ground was solid. The shaft consisted of one compartment and a manway from the surface to the 760-foot point, of two compartments and a manway thence to the 1,000-foot level and of three compartments and a manway, thence to the bottom. At the 1,000-foot level a pump was installed, the water column to the surface being a heavy, high-pressure, 6-inch pipe, fitted with 2½-inch flanges.

When the cave occurred, four men were working in the shaft bottom and the pumpman was on the 1,000-foot level. The air was suddenly filled with dust and a terrific rush of sand came down the shaft. Two men were caught by the sand and it is sup-

^a Data obtained from a source outside the company organization, but believed to be reliable.

^b Walter, E. W., Rescuing the men entombed at Alpha shaft: Eng. and Min. Jour., vol. 85, Feb. 22, 1908, p. 407.

posed were killed instantly. The other two, being somewhat protected, managed to gain the manway and climbed to the 1,000-foot level where they joined the pumpman. After things seemed to have settled the three men investigated their situation. They unbolted the flanged elbow between the water column and the pump and began to signal by tapping the pipe. The tapping was heard at the surface and the column was disconnected at the cellar, a hand windlass was rigged and a letter lowered by means of a weight at the end of 1,000 feet of $\frac{1}{2}$ -inch rope. The column was found continuous, the men below extracted the message with an old bolt and a piece of wire bent into a hook and communication was thus established. For lowering food and other supplies a series of 4 and 6 inch nipples of 2-inch pipe were connected by eye-bolts through their caps and by flexible links to form a train. A message was sent to the men directing them to connect the telephone to the power cable and thus easy communication was had. Reading matter, blankets, and other conveniences were lowered and the imprisoned men made fairly comfortable.

The work of rescue was started. From the 440-foot point, for 40 feet down, a chamber 20 by 30 feet had caved out. At the 480-foot point the shaft was closed with debris. The timber remaining above in the shaft was caught up with stringers under the wall plates, held by 1-inch wire cables from the surface. A crib was built from the debris to the stringers, 100 cords of wood filled in behind it, and the shaft timbering extended with regular sets inside this crib. The shaft was continued through the debris with spiling, broken timber making the work slow and rendering great care necessary. The column which was used to supply the men was found almost disconnected where it had taken the force of the caving. When 50 feet had been gained, the new timbering began to settle and it was found impossible to hold it. It was therefore disconnected so as to take the strain off the uncaved timbering, and unequal settling was corrected with angle braces. Finally by fighting for every inch, the 600-foot station was reached on January 18, and was found to be the bottom of the cave. A small hole was made in the matted timber at that point, the imprisoned men instructed how to do some clearing at their end, and their rescue, after being imprisoned a month and a half, was successfully accomplished.

DROWNING AND ASPHYXIATION.

WHARTON SHAFT, OCTOBER 19, 1911.

On October 19, 1911, the new shaft, No. 12, of the Wharton Steel Co. at Hibernia, N. J., was flooded and 12 men were drowned. A drift was being run on the No. 10 level toward some old workings that were known to be full of water. While the face of the drift was still 172 feet from these old workings as indicated by survey, the water broke through after a blast and trapped the 12 men, five of whom were in the shaft bottom and the rest in workings below the No. 10 level. The water is stated to have issued from an 18-inch hole under only a 30-foot head, yet the men seemed unable to climb against it as it poured down the shaft. The precaution of checking the survey had been taken; the water had been lowered sufficiently to permit driving No. 8 level to the old workings and the old survey had been found correct. The water appeared to issue from a water-course whose existence was not known. Even probing with a drill hole might easily fail to disclose such conditions and the accident would fall with those classed as unavoidable.

DALY WEST MINE, SEPTEMBER 4, 1911.

A most unusual accident occurred at the Daly West mine, Park City, Utah, in which two men were drowned. Below the drainage level of the mine, the 2100, the shaft had been continued as a sump about 17 feet deep, which was always full of water. Men were hoisted and lowered through this shaft on three-deck cages. The company recognized the possible danger and had a standing rule that the men should ride on the top deck only. According to the testimony before the coroner's jury, seven men came off the "graveyard shift" at about 7 a. m., September 4, 1911, a holiday, and found the cage at the level with the middle deck about a foot above the floor of the station. Ordinarily there was a shift coming down, and the men going off shift took the places on the upper deck of the cage which were vacated by the men of this shift. In this case they got on the middle deck of the cage at once and one of them rang three bells, the hoisting signal for men, according to the testimony of the survivors. Instead of the cage going up, it went down. The men felt the water coming up around them and the one who had pulled the bell cord jumped and reached the station. The others attempted to climb through the cage to the upper deck. Some of them succeeded and others did not. The man who had reached the station signaled three bells again and the cage was pulled to the surface with three men. The man who had jumped helped one more man to crawl out of the sump. The remaining two were later found dead in the water. Apparently they had been knocked off the cage as it started upward. The man operating the hoist, who was not the regular engineer, testified that the cage was "hanging in the shaft" and therefore was subject to his control until called to the level by two bells. And he testified also that he received two bells, the lowering signal, instead of three, and supposed that the men were calling the cage to the level so as to get on the upper deck. It was impossible to fix the responsibility in the face of the conflicting testimony.

HIRD SHAFT, AUGUST 10, 1912.

The Hird shaft being sunk by the Frontier Mining Co. at Benton, Wis., had been carried down 60 feet and then allowed to fill with water to within 25 feet of the surface in order that some new pumps might be installed. A shift boss and two skilled miners were engaged in this work on the surface and were alone on the job. On the evening of August 10, 1912, these men did not return from work, but it was supposed that they were working overtime. When an investigation was made the next morning, however, the three were found dead in the shaft and with them a farmer, the owner of the land on which the

sinking was being done. The shaft was found to contain gas; the men were either drowned or asphyxiated. The farmer was surely asphyxiated, since his head was out of water. It is supposed that one of the men went down into the shaft, where he had no business, either for a drink or from curiosity, and was overcome by gas, and in the attempt to rescue him the others were overcome. It seems most likely that they were affected first by the gas and then fell into the water. At what time the farmer was killed is uncertain. Tests of the gas in the shaft bottom showed it to be incapable of supporting combustion, it therefore was probably chiefly carbon dioxide. The shaft was in a marsh, but the action of the pumps had kept the air pure while sinking was in progress. The only possible precaution against accidents of this nature would seem to be common sense on the part of the workmen, reinforced by training and education.

SANTA GERTRUDIS MINE, APRIL 14, 1910.

An asphyxiation accident occurring at the Santa Gertrudis mine in Pachuca, Mexico, was of a most unusual nature. An explosion in the compressed-air system took place on April 14, 1910, and resulted in the death of seven men underground. The explosion can not be exactly located, but probably took place in the air receiver next to the compressor. The only immediate damage was the breaking of the discharge line from the receiver. The line was not entirely disconnected, however, and as the electrically-driven compressor continued to run for several revolutions, the noxious products of the explosion were forced down into the mine. In one of the underground winzes in process of sinking a pump was running. The effect of the explosion was to stop the pump, but, probably because the power service was irregular at the time and the stoppage of the pump not unusual, the pumpmen did not close the air valve, although orders to this effect were in force. It happened that the other air-outlet valves in the mine were closed so that all the products of the explosion were directed into the one winze. The length of the 3-inch pipe line from the receiver to the winze was 5,000 feet; yet the gases arrived in only a few minutes. The pumpmen were first overcome and fell on the miners below, giving them their first warning of danger. Five miners were rescued, the other five and the two pumpmen being either asphyxiated or drowned, the water rising rapidly in the winze after the pump stopped.

Provisions intended to diminish the risk of receiver explosions are given in section 36 of the code drafted by the committee, but constant care in the operation of the compressor is absolutely necessary.

CHAPTER XII.

COMMENTS ON A RECENT REPORT OF A BRITISH ROYAL COMMISSION ON METALLIFEROUS MINES AND QUARRIES.

By W. R. INGALLS.

CHARACTER AND SCOPE OF THE COMMISSION.

A royal commission consisting of nine members, Sir Henry Hardinge Samuel Cunynghame, chairman, was appointed in 1907 to report on questions pertaining to the health and safety of miners in the metal mines and the quarries of England and Wales. The second report of this commission was made in June, 1914, following an extensive inquiry which included the examination of many witnesses representing workmen and owners and the taking of testimony of inspectors, engineers, physicians, etc. The work of the commission will thus be seen to correspond somewhat to the work of our committee, and it is consequently of interest to examine the material presented in its report.

It is well recognized that mining conditions in England and Wales are wholly different from those in the United States. The investigations of the commission covered questions of disease as well as safety, and quarry operations received a good deal of attention; its methods of procedure were entirely dissimilar to those followed by our committee; finally the commission did not formulate a code but merely made certain recommendations. Bearing in mind these essential points of difference, a brief review of parts of the British report may be made, especially those referring to subjects covered in our report.

MISCELLANEOUS FEATURES.

Comment may well be made first regarding certain miscellaneous and scattered points of interest. The commission found a great difference of opinion existing as to the desirability of safety catches on cages. Evidence was given to the effect that they not only failed to eliminate accidents, but even caused them. Even their sponsors admitted that they are not infallible and to be at all reliable should be correctly designed and well looked after. The commission seems inclined to recommend them for wooden guides in vertical shafts, provided more proof as to their efficacy can be had. A somewhat similar uncertainty was brought out in regard to detaching hooks.

Automatic speed regulators were decided to be unnecessary. (Our code prescribes safety catches and detaching hooks or automatic stops under certain conditions.)

The question of hoisting ropes was not considered in any great detail, but the commission recommends that three and one-half years be made the maximum life of ropes used for hoisting men, that spliced ropes for man hoisting be prohibited, and that ropes be recapped every six months. Recapping for haulage ropes is also prescribed. (Our code specifies no time limit, permits splicing, and requires recapping at periods corresponding to the use of the rope.)

Where hoisting is done in balance, it is recommended that men be not handled when material such as ore or rock is in the balancing-shaft vehicle. This practice is extremely unusual in the United States and would seem hardly to merit special prohibition in a general code.

In regard to ladderways, two recommendations, namely, that the maximum inclination be 75° and that sollars be required every 30 feet, differ only in degree from the specifications in our code, which require 80° inclination or flatter, and sollars at 20-foot intervals under certain conditions.

Concerning the question of the flooding of mine workings, the commission cites an accident illustrating a rather unusual hazard. An inrush of water into the workings of a certain mine drowned one man and imprisoned several others; it also washed to the shaft a piece of loose timber which got entangled with the cage and prevented its release, even by divers, for some time. The commission therefore recommends that loose timber should not be allowed to accumulate in main roads. The danger of floods in general, it is pointed out, is serious in metal mines, inasmuch as many ancient unmapped workings exist in English mining districts.

In regard to explosives, it is urged that fuse have a covering impervious to such casual moisture as exists in rock fissures and one capable of resisting reasonable bending tests, and that the rate of burning be shown on a label attached to every coil. (Our code specifies limits to the rate of burning and requires the rate to be posted at the mine entrance.) Where work is done on contract, it is held that the mine owner should furnish the explosives, and if they are charged against the contractor, the charge should cover only actual cost, the object of the provision being to prevent the relatively ignorant contractors from experimenting with untried materials.

A somewhat unexpected difficulty was brought out in regard to the specifications for tamping rods and prickers. The commission was inclined to limit the materials of which they might be made to copper and wood. (Our code requires wood tamping bars.) One operator of a salt mine made the objection that when drilling in salt there was no possibility of striking fire with an iron bar and that the nature of

salt resulted in a drilled hole being very rough and irregular so that copper tools would get stuck. Phosphor bronze has been found to break off and steel had proved unsatisfactory, the best material for the purpose being charcoal iron.

The commission recommends that the diameters of drill bits and explosives cartridges be standardized in order to avoid the danger of excessive ramming, such as would be required with a cartridge too small for its hole. A further recommendation would prohibit the firing of a hole simultaneously with two kinds of explosives.

As regards the matter of ventilation, the commission expresses itself as favoring a provision that in all workings where ordinary work is proceeding the management be required to maintain the air in such purity that the oxygen percentage at the breathing level shall exceed 19 per cent and the carbon dioxide percentage shall be less than 1.25 per cent. Quantitative specifications regarding carbon monoxide and the nitrogen oxides are omitted. (Our code requires merely adequate ventilation.)

Following an investigation that tended to show that fibrosis and tuberculosis were not brought on by rock dust unless this was largely composed of fragments of crystalline silica, but that the maladies were extremely prevalent when this silica dust was present in quantity in the atmosphere, the commission advises that when machine drilling is carried on in siliceous rocks the dust shall be kept from entering the atmosphere by the use of water, preferably by water conducted to the bottom of the hole; that water blasts shall be used to lay dust raised by blasting; that spitting underground be eliminated to as great an extent as possible; and that when rock is crushed or worked on the surface so as to generate large quantities of dust this should be kept down by the use of water. (These are certainly desirable prescriptions wherever it be possible to enforce them.)

The commission was not impressed with the danger of underground fires in metal mines and thus does not make recommendations for the providing of rescue apparatus and drill in rescue work. It does, however, specify ambulances for properties over a certain size, where hospital ambulances are not available. (American experience has pointed emphatically to the great danger of underground fires, as appears repeatedly in our report.)

In addition to maintaining change houses, the commission believes that the managements should in many cases provide suitable mess-rooms where the men may eat. Change houses, it is thought, should be whitewashed or painted at regular intervals.

When accidents occur, the commission recommends that the place of the accident be left untouched for a suitable length of time, so that the inspector can examine it in the condition in which the accident left it.

SUMMARY OF COMMISSION'S RECOMMENDATIONS.

At the end of its report, the commission summarizes its main recommendations. It may be well to give an abstract of parts of this summary, omitting legal sections, those requiring undue explanation or reference to other codes, those falling without the scope of this report, and those of local applicability only. Recommendations substantially identical with those of our committee have been marked by asterisks.

A brief summary follows:

Provision should be made for the examination of working places by the men and facilities given them for inspecting places where accidents have occurred.*

Mines employing more than 12 men underground and quarries employing more than 25 persons inside should be under the control of a manager over 25 years old with more than five years' practical experience, holding a qualifying certificate granted after an oral examination. (This would correspond approximately to the requirements in our code for superintendent.) Mines employing more than 100 men (except stone, slate, gypsum, salt, or clay mines) should be handled by a manager holding a first-class certificate which would indicate a certain amount of technical knowledge and be granted after written examination. A consulting mining engineer, similarly qualified, may take the place of the manager. The manager should be responsible for the operation of the property and be held jointly liable with the owner and agent for the observance of regulations. There should be a limit as to the number of properties for which one man may act as manager.

In metal mines there should be an examination of the working places and roads at least once a day by a mine official, who should enter in a book the signed report on his examination.* This official should not have other duties that would interfere with the work of inspection. Such inspectors should have at least five years' experience underground and be over 25 years old.

A daily examination should be made of the face and overburden of quarries and a very careful examination at least once a month by a person qualified about as is the underground inspector.

Breaches of discipline by the men should be prosecuted and owners should be compelled within three weeks thereafter to send to the mine inspector reports of any prosecutions of employees for violations of provisions of the statute.

Inspection of the sides and roof of workings should be provided for,* and where pillars are left for support, they should be of a size and spacing sufficient to insure safety.

The official who inspects working places should supervise the timbering, and, in stratified deposits, give general directions as to how the timbering is to be done.

In vertical raises the box method of timbering or something of the same nature should be followed. (The "box" method consists, in brief, of dividing the raise into three compartments, using the center compartment for handling the broken material and the two end compartments for ventilation, supplies, and the passage of men.)

A proper quantity of timber should be supplied by the owner, in the workings if possible, otherwise at the mine entrance.

High workings should be carefully and periodically inspected by the aid of some powerful illuminant.*

In quarries, new galleries^a should be kept below a height of 60 feet with the width greater than half the height, except in special cases; where practicable old galleries over 100 feet high should be reduced in height.

Care in the storage of inflammable material, the use of fireproof buildings over shafts, provision for putting out fires around the shaft collar, and the elimination of inflammable material in the construction of underground engine-rooms are advisable.*

Shafts in which men are handled should be inspected at least weekly. Hoisting signals should be made uniform. Certificates of competency for hoisting engineers are not considered necessary, nor limitations on their hours of labor. The separation of the hoist room so as to leave the engineer undisturbed; the use of indicators and efficient brakes; the inclosure of the lower parts of cages; trial runs through the shaft before handling men; adequate inspection of all hoisting apparatus—these are recommended. (In addition, certain hoisting provisions were noted previously. About the same provisions with others will be found in our code.)

Ladderways should be separated from other parts of the shaft* and receive adequate inspection.* (Other precautions in ladder installation were commented on before.)

New mines should be provided with a shaft capable of containing an emergency ladderway equipped with ladders;* a second exit should be provided when the inspector deems it necessary. (Our committee makes the second exit compulsory in most cases and leaves no such important decisions to the discretion of the inspector.)

All explosives should be subjected to Government test if possible. Storage of explosives should be permitted underground in metal mines.* Owners should provide suitable places for storage at quarries and both on the surface and underground at metal mines. Pre-

^a The term "galleries" would appear to mean benches or steps.

cautions should be taken with explosives liable to freezing.* The proper drilling and placing of holes and the use of suitable tools should be insured. The stemming should not be removed in the case of misfires unless safety appliances have been used; misfires should not be handled except after a sufficient interval.* (Other recommendations regarding explosives were noted before. Most of these requirements are in our code.)

Precaution should be taken at quarries in "springing" holes; shelters against blasting should be provided and used; quarry blasting signals should be clear and distinct and uniform throughout the country. Handling rock by cableways should be stopped while blasting is going on. Danger attendant on monster blasts in quarries should be guarded against by special provisions.

Certificates of competency or, except in the case of electrical firing, special authority from the management, is not necessary for shot firers or blasters. Men firing shots should examine the working afterwards before ordinary work is allowed to proceed.*

There should be provision for steam boiler inspection and fencing of machinery.*

Where horses are used, there should be sufficient room in underground haulageway. Haulage signals should be made uniform, and a minimum age imposed on haulage engineers.

Where tracks are used along the edge of quarries or their galleries, in general, not less than 5 feet should be left between the outside rail and the edge. When men work on ledges or faces where the sheer fall is more than 15 feet, ropes or chains should be used; these should be examined daily by the men using them and should be periodically inspected by a quarry official.

The wet-bulb temperature of underground air should be kept below 80° F. in still air and below 85° in moving air, so far as possible. In mines less than 1,200 feet deep, the roads and working places should have such ventilation as will keep the wet-bulb temperature below 80°. Where practicable, proper means should be taken to keep separate the upcast and the downcast air. (Other ventilation provisions were commented on.)

Precautions should be observed where the presence of poisonous gases in mine workings is suspected and when fighting mine fires. (The subject of rescue work has been mentioned.)

Changing, washing, and drying accommodations should be provided where wet or dirty material is worked, the accommodations based on an allowance of 150 cubic feet per man. With more than 10 men employed, mess rooms and drying facilities should be furnished at quarries and at mine surface works. If the number of men is large, the drying room should be separated from the mess room.

Plans of mines should be prepared by certified surveyors; should show the relation of surface to underground workings with connection to the nearest Government benchmark, the depths of all shafts, the numbering of the levels, the position of underground dams and their structure; the plotting should be to true north on a uniform scale; the maps should be brought up to date every six months, kept on durable material, and show sections of the several deposits being worked; the requirements for maps should apply to all mines irrespective of size. (Our committee requirements are substantially the same.)

PUBLICATIONS ON MINE ACCIDENTS AND METHODS OF MINING.

A limited supply of the following publications of the Bureau of Mines is available for free distribution. Requests for all publications can not be granted and applicants should limit their selection to publications that may be of especial interest to them. Requests for publications should be addressed to the Director, Bureau of Mines, Washington, D. C.

BULLETIN 17. A primer on explosives for coal miners, by C. E. Munroe and Clarence Hall. 61 pp., 10 pls., 12 figs. Reprint of United States Geological Survey Bulletin 423.

BULLETIN 45. Sand available for filling mine workings in the Northern Anthracite Coal Basin of Pennsylvania, by N. H. Darton. 1913. 33 pp., 8 pls., 5 figs.

BULLETIN 52. Ignition of mine gases by the filaments of incandescent electric lamps, by H. H. Clark and L. C. Ilsley. 1913. 31 pp., 6 pls., 2 figs.

BULLETIN 53. Mining and treatment of feldspar and kaolin in the southern Appalachian region, by A. S. Watts. 1913. 170 pp., 16 pls., 12 figs.

BULLETIN 60. Hydraulic mine filling; its use in the Pennsylvania anthracite fields; a preliminary report, by Charles Enzian. 1913. 77 pp., 3 pls., 12 figs.

BULLETIN 69. Coal-mine accidents in the United States and foreign countries, compiled by F. W. Horton. 1913. 102 pp., 3 pls., 40 figs.

BULLETIN 80. A primer on explosives for metal miners and quarrymen, by C. E. Munroe and Clarence Hall. 1915. 125 pp., 15 pls., 17 figs.

TECHNICAL PAPER 6. The rate of burning of fuse as influenced by temperature and pressure, by W. O. Snelling and W. C. Cope. 1912. 28 pp.

TECHNICAL PAPER 7. Investigations of fuse and miners' squibs, by Clarence Hall and S. P. Howell. 1912. 19 pp.

TECHNICAL PAPER 11. The use of mice and birds for detecting carbon monoxide after mine fires and explosions, by G. A. Burrell. 1912. 15 pp.

TECHNICAL PAPER 13. Gas analysis as an aid in fighting mine fires, by G. A. Burrell and F. M. Seibert. 1913. 16 pp., 1 fig.

TECHNICAL PAPER 17. The effect of stemming on the efficiency of explosives, by W. O. Snelling and Clarence Hall. 1912. 20 pp., 11 figs.

TECHNICAL PAPER 18. Magazines and thaw houses for explosives, by Clarence Hall and S. P. Howell. 1912. 34 pp., 1 pl., 5 figs.

TECHNICAL PAPER 19. The factor of safety in mine electrical installations, by H. H. Clark. 1912. 14 pp.

TECHNICAL PAPER 21. The prevention of mine explosions, report and recommendations, by Victor Watteyne, Carl Meissner, and Arthur Desborough. 12 pp. Reprint of United States Geological Survey Bulletin 369.

TECHNICAL PAPER 22. Electrical symbols for mine maps, by H. H. Clark. 1912. 11 pp., 8 figs.

TECHNICAL PAPER 24. Mine fires, a preliminary study, by G. S. Rice. 1912. 51 pp., 1 fig.

TECHNICAL PAPER 29. Training with mine-rescue breathing apparatus, by J. W. Paul. 1912. 16 pp.

TECHNICAL PAPER 30. Mine-accident prevention at Lake Superior iron mines, by D. E. Woodbridge. 1913. 38 pp., 9 figs.

TECHNICAL PAPER 40. Metal-mine accidents in the United States during the calendar year 1911, compiled by A. H. Fay. 1913. 54 pp.

TECHNICAL PAPER 41. The mining and treatment of lead and zinc ores in the Joplin district, Missouri; a preliminary report, by C. A. Wright. 1913. 43 pp., 5 figs.

TECHNICAL PAPER 46. Quarry accidents in the United States during the calendar year 1911, compiled by A. H. Fay. 1913. 32 pp.

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TECHNICAL PAPER 48. Coal-mine accidents in the United States, 1896-1912, with monthly statistics for 1912, compiled by F. W. Horton. 1913. 74 pp., 10 figs.

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MINERS' CIRCULAR 4. The use and care of mine-rescue breathing apparatus, by J. W. Paul. 1911. 24 pp., 5 figs.

MINERS' CIRCULAR 5. Electrical accidents in mines, their causes and prevention, by H. H. Clark, W. D. Roberts, L. C. Ilsley, and H. F. Randolph. 1911. 10 pp., 3 pls.

MINERS' CIRCULAR 8. First-aid instructions for miners, by M. W. Glasgow, W. A. Raudenbush, and C. O. Roberts. 1913. 67 pp., 51 figs.

MINERS' CIRCULAR 10. Mine fires and how to fight them, by J. W. Paul. 1912. 14 pp.

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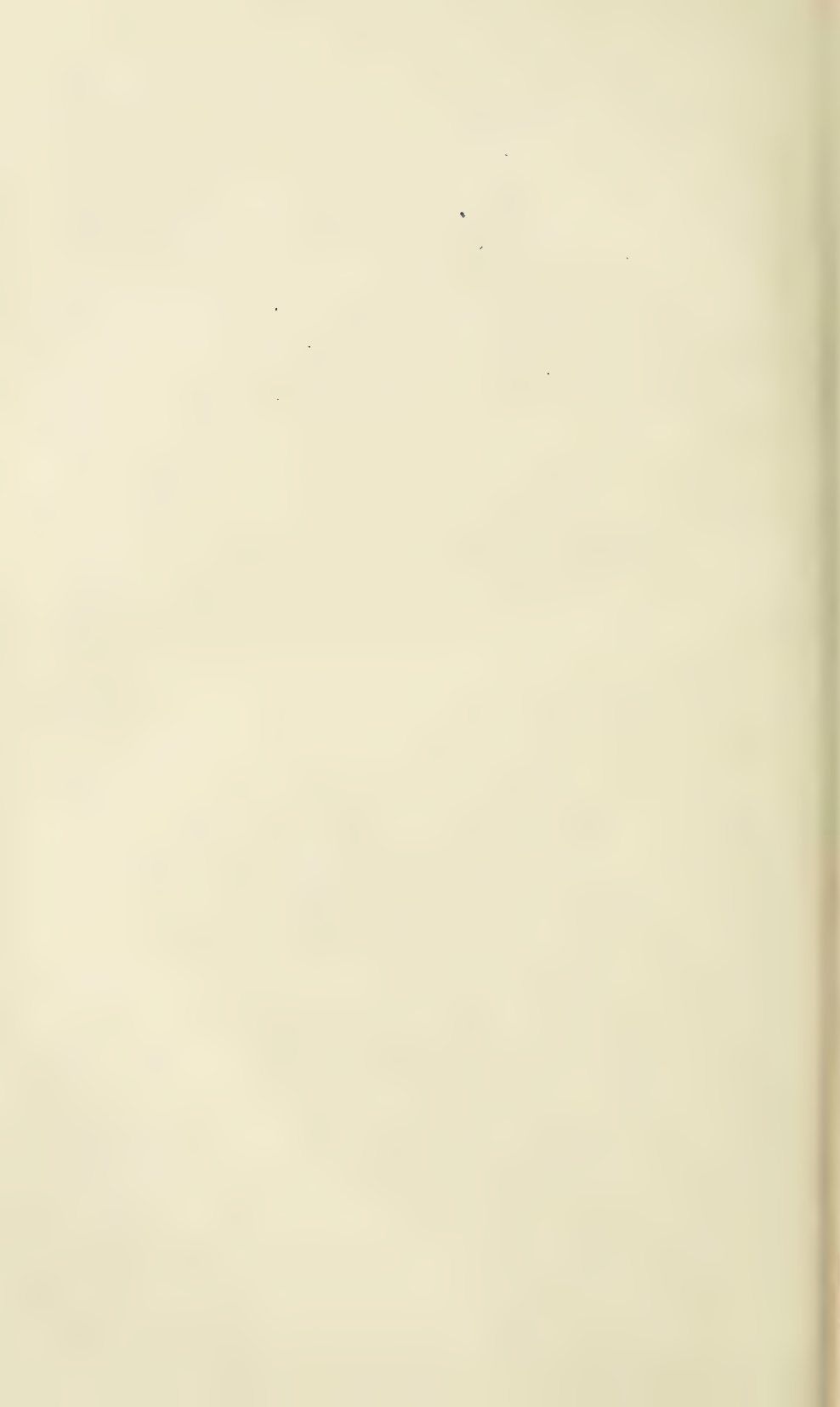
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MINERS' CIRCULAR 19. The prevention of accidents from explosives in metal mines, by Edwin Higgins. 1914. 16 pp., 11 figs.



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